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1. MANAGEMENT

Aromatics

Oil Industry Moves Further into Aromatics. *Oil Gas J. 59,* 116 (1961) July 3 (2 pp.)

Toluene and xylene production from petroleum has outstripped that from coal since 1955, and the gap is widening. Benzene from toluene amounted to 50 million gallons in 1960; projected conversion in 1962 is 150 million gallons. Petroleum naphthalene is expected to press coke-oven naphthalene closely in 1962. Petroleum-based aromatics capacities are expected to be up sharply in 1962 compared with 1960 capacities. Benzene production from petroleum passed that from coal in 1958, and the gap has steadily widened ever since.

Competition

What's Ahead for Oil Heat? *Nat. Petrol. News 53,* 113 (1961) June (2 pp.)

In 1950 oil was used to heat 22.6% of the 42.9 million dwellings in the United States. In 1960 the figure was 31.5% of 52 million dwellings—an increase in market share of 8.9 percentage points. Gas has progressed more swiftly. In 1950 it held 26.6% of the available market (that is, of the total number of dwellings). In ten years gas built its share of the market to 43.1%—an increase of 16.5 percentage points. Electricity, a relative newcomer to the market, had by 1960 still captured only 1.5% of the total market. But this was more than double its market of ten years before, a phenomenal rate of growth that appears likely to continue. Some consider electricity oil heat's biggest long-range contender.

Cost Accounting

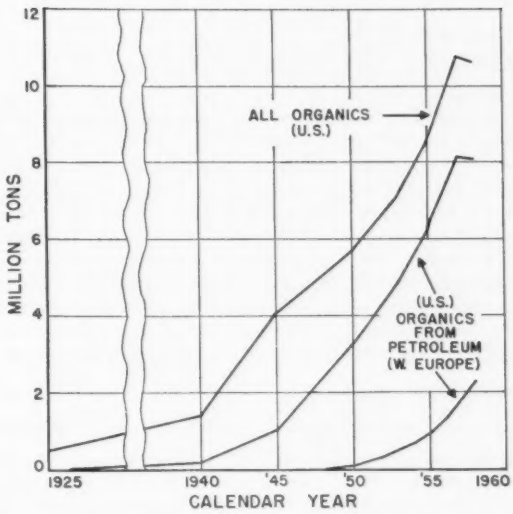
Cost-Capacity Factors—Equipment. O. T. Zimmerman and I. Lavine. *Cost Eng. 6,* 13 (1961) Apr. (10 pp.)

To estimate the cost of a plant or a piece of equipment of given capacity from the known cost of a plant or piece of equipment of different capacity, the "six-tenth factor" rule is often used. This simple relationship is expressed by the equation: $C_2 = C_1(V_2/V_1)^{0.6}$ where C_1 = known cost of plant of capacity V_1, C_2 = desired cost of plant or equipment of capacity V_2. Unfortunately, like many other simple relationships, the use of this equation can lead to serious error, for the cost-capacity factor, or exponent, 0.6, is a mean value, and a mean value can lead to erroneous results when applied to a specific case. A number of items are listed together with their actual cost capacity factors. These include: crystallizers, dryers, dust collectors, filters, power plant equipment, tanks, kettles, reactors, and vibrating screens.

Plant Investment Costs by the Factor Method. S. M. Walas. *Chem. Eng. Prog. 57,* 68 (1961) June (6 pp.)

Estimate fluid processing plant costs rapidly using a simple nomograph. Simple methods for estimating completed plant costs are desirable. By applying a multiplying factor to equipment costs an approximation may be made to plant costs. Greater accuracy can be achieved by employing different factors for each type of equipment. The factors can be readily and accurately evaluated from the nomograph.

Organic Chemicals from Cracked Hydrocarbon Gases



(Adapted from *Chem. & Ind.* . . . See Abstract, p. 151)

Drilling

Contractors' Survival Kit. J. Sheehan. *Drilling 22,* 46 (1961) June (6 pp.)

For the purpose of demonstration, the various factors of cost can be applied to three fictitious drilling contracts. These totals represent a basic daywork rate only. Such items as footage risk profit factor, fuel, subsistence, and rentals should be added to the total when circumstances require. By analyzing each item of out-of-pocket cost separately and by isolating each major component of equipment from a cost-to-furnish standpoint, a resultant total has been achieved that is pure logic, and is completely defensible.

Exploration

Happy Accident Uncovered Fantastic Alberta Deposits. Public Relations Dept., Trans-Canada Pipe Lines Ltd. *Can. Gas J. 54,* 51 (1961) June (4 pp.)

Natural gas was discovered in Alberta (and for the first time in Canada) in 1883 quite by accident, by drilling what was to be a well to supply water for wood-burning locomotives. The well, midway between Suffield and Alderson, a few miles north, was drilled to 523 ft, but the water supply was inadequate so it was deepened. On reaching 1155 ft, natural gas was struck. The gas caught fire and the drilling rig was destroyed. A year later another well was drilled nearby, with gas from the

discovery well used to power the second drilling operation. The second well also found gas at 1155 ft, at the rate of 50,000 CF daily.

Federal Regulation

The Federal Power Commission. N. Regeimbal. *Gas 37,* 41 (1961) July (3 pp.)

The Federal Power Commission in recent years has been under increasing criticism. At the same time as a result of various court decisions, its work load has grown tremendously and the web of regulation of gas and power has grown vastly more complex and tangled. Some basic changes in its make-up, powers, and duties are inevitable. The result is likely to be simply attempts to unsnarl and speed up the FPC regulatory process. This is the first of a 3-part study of the history of the agency, its present position, and its probable future, to aid in a better understanding of events of the next year or two as they unfold.

Foreign Activities

Mexico's Refining and Petrochemical Industry. C. O. Baptista. *World Petrol. 32,* 49 (1961) June (5 pp.)

Growth in average refinery products yield over the past twenty years has been from 77,690 to 286,070 bbl daily. Originally, there were 7 small topping plants with a nominal capacity of approximately 140,000 bbl/day topping capacity, and a very much lower cracking capacity; seven refinery installations today have nearly 3 times the topping capacity, and in addition have expanded their operations to include practically complete refinery works. All equipment with but one exception was installed after 1942 and is thoroughly modern in design and operation. Since no technical personnel with experience in heavy equipment was available at that time in the country outside the oil industry, a program based on the on-the-job training of young engineers just out of school was started. This program has continued without interruption ever since, and through it, the technical staff of the Mexican refineries has grown from 70 to 700 during this period. At the same time, the average experience has increased from 4 years to 12 years, and today, every young engineer that starts working has always a senior engineer to teach and train him so he matures more easily and completely than the small group which had to train itself 20 years ago.

Natural Gas Prospects. *Petrol. Times 65,* 327 (1961) May 19.

J. W. Kerr, Chairman and president of Trans-Canada Pipe Lines, Ltd., recently told the Security Analysts Association of Toronto that discoveries of natural gas in Alberta during 1960 were almost twice as great as officials of his company expected. Mr. Kerr said that about 5 trillion CF were discovered in Alberta last year while the National Energy Board predicted a year ago that the year's discoveries would total 2.9 trillion CF. Growth in proved reserves in Alberta lately has been particularly rapid, with just under a trillion CF becoming available in the past few months. Exploration continues in northern British Columbia and the Northwest Territories, and it is not impossible that these areas together could be found to have more gas than Alberta. In 1960, the Canadian gas industry delivered to market 0.324 trillion CF compared with a total of proved reserves in Canada in that year of 32.7 trillion CF. Canada's proved reserves are expected to rise sharply in future years: to 35 trillion CF by the end of 1961; to 45 trillion by 1965; 78.5 trillion by 1980 and at least 95 trillion by 1990.

The Stockholm Gas Works. S. Dahlbeck and C. G. Lilje. *Gas- und Wasserfach 102,* 636 (1961) June 9 (5 pp. German text.)

Visitors to the June 1961 meeting of the International Gas Union in Stockholm were afforded an opportunity of inspecting its Varta gas works. In operation since 1954, the works now comprises facilities for producing daily 21 MMCF coal gas, 3.5 MMCF oil gas and 3.5 MMCF propane-air gas. Coal (German, English, and American) is carbonized in 5 batteries, 2 of 23 ovens and 3 of 19 ovens. Coal handling and gas purifying plant is described. Gas is distributed by high (suburban) and medium (city) pressure networks totaling 550 miles.

Hydrogenation

Production of Low Molecular Weight Hydrocarbons from Solid Fossil Fuels. M. A. Elliott, H. R. Linden, and E. B. Shultz, Jr. (assigned to Institute of Gas Technology) U. S. 2,991,164 (1961) July 4.

A process is claimed for making an ethane-rich gas by hydrogenating a fossil type fuel such as oil shales, cannels, or asphaltites. Hydrogen in 50% stoichiometric quantity required to convert the organic carbon and hydrogen of the solid to methane is reacted at over 1000 psig and 1100° to 1300°F. Ethane is recovered from product gas and part of the tail-gas is reformed to produce the required hydrogen. A pyrolysis stage for ethane is also claimed for producing ethylene.

Information

Information Retrieval—A Solution. B. E. Holm. *Chem. Eng. Proc. 57,* 73 (1961) June (6 pp.)

Most effective solution to data retrieval problem is the indexing of material by the originator rather than multiple indexing by recipients. The A.I.Ch.E. is presenting the system discussed as an economical, effective solution to the problem. Readers are asked to use the system, determine its benefits, make suggestions for its improvements to the editors, and expand this approach by encouraging other societies and publishers to adopt this service.

LPG

Alberta Outlines Gas-Liquids Policy. *Oil Gas J. 59,* 73 (1961) (2 pp.)

Alberta should reject sudden, large-scale export of natural-gas liquids to Chicago in favor of gradual development of existing and new Canadian and United States markets. This concept requires the construction of small gathering and truck lines as needed rather than comprehensive provincial grid systems that have been pro-

posed. This is the gist of the recommendation of the Alberta Oil and Gas Conservation Board to Premier Manning's government.

Petrochemicals

Chemical Intermediates from Hydocarbon Sources. J. R. Blanco. *Chem. & Ind., 802* (1961) June 17 (9 pp.)

In recent times, the demand for gasoline of still higher anti-knock ratings has brought changes in the refining processes directed towards the very high aromatic contents. To achieve this there has been a swing from catalytic cracking to catalytic reforming, the latter producing high yields of aromatics from straight-run petroleum fractions but no light olefins. Plants producing hydrocarbons for chemicals manufacture are by no means confined to the major petroleum companies and their subsidiaries. In the present situation in Europe, petroleum fractions suitable for cracking are abundant, cheap, and available to any chemical manufacturer. Data for the United States and Europe are given, both as to production and availability of petrochemical raw materials.

Pipeline Construction

Crossing the Sete Sea Channel. M. Duval *J. Ind. Gaz 85,* 253 (1961) June (3 pp. French text.)

Laying of two gas transmission mains across the sea channel 70 meters in width is described as well as the operations and civil engineering problems that had to be solved.

Many Variables Affect Construction Costs. *Oil Gas J. 59,* 140 (1961) June 26 (13 pp.)

Pipeline economics differ from other forms of transport and between and within types of lines. Pipelaying costs have varied up to 1,000%; station costs have varied 375%. Every year about 12,000 miles is added to the interstate pipeline system in the United States. At the end of 1959, these lines totaled 375,000 miles. By the end of this year they should reach 400,000 miles. This is supplemented by thousands of miles of intrastate lines. Oil pipelines have waged a so-far successful battle against increasing costs. Indications are that gas transmission costs are rising faster than gas transmission lines are growing. This parallels oil's situation in that it is a trend that will eventually but inevitably end. Another seemingly significant indication is the declining rate of return for natural gas pipeline companies.

Work on Dixie LPG Line Will Start in July. *Oil Gas J. 59,* 124 (1961) June 26 (2 pp.)

Construction of the nation's newest major pipeline—the 1077-mile Dixie LPG system from Mont Belvieu, Tex. to near Raleigh, N. C.—will get under way in July. The start of work will climax a rivalry between Dixie LPG Pipeline Co. and Trans-Southern Pipeline Corp. Both companies proposed LPG lines to serve the southeastern part of the United States. Dixie's will be the second big LPG system in the country. The first, Mid-America Pipe Line Co.'s 2184-mile line from New Mexico to the upper Midwest, has operated less than a year.

Pipeline Systems

Pipeline Systems of Pemex. B. Mascanzoni and F. X. Peredo. *World Petrol. 32,* 48 (1961) June (5 pp.)

With existing lines for crude, natural, and gas totalling 5228 miles, Pemex plans 1175 miles of new lines and expansion projects. During 1961, 42.2 million dollars are to be expended for underway projects, plus 6.5 million dollars for new lines. The main purpose of lines built before 1938 was to transport crude oil production from fields to the ports of Tampico, Tuxpan and Minatitlan, either for export as crude or for partial refining and export of products. In 1938 there were approximately 1231 miles of lines—1070 miles for oil and 161 for natural gas. At present Petroleos Mexicanos has a total of 5228 miles of pipelines distributed as follows: oil, 1974 miles; products (including gasoline, kerosene, diesel fuel, butane, and propane), 1235 miles; and natural gas, 2019 miles.

Ratemaking

Measuring Price-Supply Relationship for Natural Gas. T. H. Levin and D. Berman. *Public Util. Fortnightly 68,* 1 (1961) July 6 (11 pp.)

Is there a necessity for manufacturing corporations in pricing differentiated products, as is the case in the sale of natural gas, to undertake an estimate of demand at various price levels? The economic concept of elasticity of supply and demand, its application to the natural gas industry, and the need for companies to prepare a demand schedule are discussed, especially when public utilities must make assumptions of the relationship of price and demand when they submit revised rate schedules to regulatory agencies.

Research

Russia Reshuffles Its Science. *Business Week,* 45 (1961) July 1 (3 pp.)

The Soviet Union is again overhauling its gigantic scientific research and development program, in the fear that its results are not keeping pace with soaring costs. An early victim of governmental pruning is apt to be the "pure" researcher. New technology for 1960 was to introduce 891 projects, instead the process was completed in only 64% of the projects; and in 10% didn't even get started. Russians are having trouble picking and training young scientists and fitting them into the main research patterns. Of the 4000 scientific doctorates awarded in the past 10 years, fully half went to people more than 50 years old.

Safety

Furnace Protection Makes a Big Step Forward. *Combustion 32,* 34 (1961) June (4 pp.)

Protection of multiburner flame boiler furnaces against explosion hazards is much advanced in a new flame scanning system at American Optical Co.'s plant at Southbridge, Mass. Fused quartz rods sealed into furnace walls are pointed to "discriminate" each main burner and pilot flame. The rods by internal reflection

lead the light to a cooler (600°F) zone, where a lead sulfide scanner or an optical coupling is attached. The latter permits use of a flexible bundle of coherent (parallel) glass fibers to transmit light to a more convenient scanning location. Final details of application and standardization of installations offer great promise.

Foam Compounds for Use Against Fires in Water Miscible Solvents. P. Nash and R. J. French. *J. Inst. Petrol. 47,* 219 (1961) June (4 pp.)

Modern protein-based foam compounds while not very effective against fires in liquid hydrocarbons with firepoints below 100°C (212°F) give little or no protection against fires in water miscible solvents, as these cause a rapid breakdown of the bubble-structure of the foam. During recent years, foam manufacturers have devoted considerable effort to the development of "all-purpose" foam compounds which would be effective against fires in both hydrocarbons and water miscible solvents. This article reviews the types of all-purpose compounds available, and discusses their performance on flammable liquid fires.

2. ENERGY SUPPLY AND ECONOMICS

Energy Sources

Energy and the United Nations. Edited by A. G. Mezerik, New York. *International Rev. Serv. VI,* No. 59 (1960).

Within the recent past, the United Nations has become extremely active in providing technical assistance, studies, and information in the field of energy. Since energy is so important in every phase of the planning of economic development in all underdeveloped countries, IRS brings together in this bulletin key studies, reports, programs, and plans in this field.

Energy Production and Consumption in the United States: An Analytical Study Based on 1954 Data. *U. S. Bur. Mines Rept. Invest. 5821.* (Washington, D. C.: U. S. Dept. of the Interior, Bureau of Mines, 1961; 145 pp.)

The present study continues in the path of the two earlier studies. (*I. C. 7582 and R. I. 4805*); it presents an energy balance sheet for the nation in 1954, therefore, it is directly descended from the Lyon and Colby study. In addition, as in the Barnett study, the nation's fuel economy is analyzed in detail from a number of viewpoints. With the advantage of past experience, improved data availability (unlike 1947, there was a census of mineral industries in 1954), and because it is concerned with only a single year, the present study is believed to be more rigorous in concept, broader in scope, and to offer new and substantially greater detail than either of the earlier studies.

Fuel Cells

Fuel Cells. H. H. Chambers. *Chem. & Ind.,* 777 (1961) June 10 (3 pp.)

Recent publicity has given the false impression that commercial development of fuel cells can be expected in the very near future. The true position is that, although technical feasibility has been demonstrated, there is some way to go before economic feasibility is proven. This requires more engineering development and more basic research. The high efficiency of a fuel cell results from the fact that electrochemical oxidation can be made to approach more closely to conditions of thermodynamic reversibility than can any process of power generation involving chemical oxidation and a thermal cycle. An abstract and discussion are given.

Nuclear Reactors

Cheaper Power from the Atom. *Business Week,* 33 (1961) July 8.

Pacific Gas & Electric Co. recently announced plans for a 325,000-kw atomic power plant to be built at Bodega Bay on the California coast about 50 miles north of San Francisco, at a cost of approximately $61 million. The cost of atomic power at 5.62 mills per kwh with the plant's first uranium core, and at 5.32 mills per kwh with its second, compares very favorably with other fuel. Oil-fueled steam plants of comparable size under construction in the same area are figured at 5.7 mills per kwh. Part of the credit for the fact that atomic power is more competitive goes to Pacific Gas & Electric's technical refinements; part belongs to the increased cost of oil.

Oil Shale

Retorting and Coking of Bituminous Solids. J. W. Scott, Jr. (assigned to California Research Corp.) U. S. 2,982,701 (1961) May 2.

Liquid hydrocarbons are recovered from particulate-form bituminous solids by passing a moving bed of these solids through consecutive heating and retorting zones, in countercurrent contact with heated combustion gases withdrawing from both zones the hydrocarbon products. The hydrocarbons recovered are separated into combustible product gases and the liquid hydrocarbon products. A portion of recovered gases is recycled to a lower portion of the retort zone for use in combustion. Preheating the heavy portion of the liquid hydrocarbons to 600° to 900°F causes further decomposition resulting in lighter liquid and gaseous products and coke. The preheated heavy portion is then distributed over the moving particles of bituminous solids prior to their passage through the retort zone, maintaining a temperature of at least 900°F and keeping a ratio of at least 7 lb solids per lb of the preheated heavy portion, and withdrawing the hydrocarbons of decomposition from both the heavy recycled portion and the incoming solids. Spent shale is burned with 0_2 in the lower retort to provide hot gas medium.

Plasma Technology

Plasma Jet—Progress Report 2. M. L. Thorpe. *Research/Development 12,* 77 (1961) June (11 pp.)

Technical progress in hardware design has been greatly accelerated with effort placed on simplification of

equipment and engineering for specific jobs. Life, serviceability, and reliability of components have been improved considerably through modification and "second generation" designs. New modes of operation and arc stabilization have been discovered which allow continuous operation at temperatures and velocities previously considered impossible with this type of heat source. A new electrode design allows continuous operation of the Plasma Flame Torch at enthalpies up to 60,000 Btu/lb, with a flame momentum one-half that of an oxy-acetylene welding flame. Plasma jets have found practical application for thermochemical reactions, particle spheroidization, particle vaporization, materials testing, welding, piercing, furnace melting, crucible melting, crystal growing, surface glazing, and cutting operations. (For Report 1, see *Gas Abstracts 16*, 23.)

3. NATURAL GAS AND PETROLEUM PRODUCTION

Drilling

Cosden "Foams" Oil and Salt Water from Gas-Drilled Hole. E. McGhee. *Oil Gas J. 59*, 96 (1961) June 19 (2 pp.)

The success of Cosden and Grappe in this case may have important implications for the remainder of the industry. First, it seems that areas not economical to air drill in the past because of salt-water and small-volume oil zones now may use this money-saving method. Second, it will be easier to use air or gas to clean out or work over old wells. And third, it may become attractive in many cases to extend air or gas drilling into the pay zone itself instead of stopping above it as in the past.

Existing Equipment Plays Major Role in Mohole Work. P. B. Harder. *Drilling 22*, 62 (1961) June (4 pp.)

The most noteworthy feature of Phase II of Project Mohole was the reliance on conventional oilfield equipment and techniques. Other than the four outboard diesel engines used for "anchoring" and their related positioning equipment in the pilot house, there was little aboard Global Marine Exploration Company's CUSS I that has not been part of the kit of tools available to offshore drilling firms for some time. The big distinction between the holes cored by the CUSS off Guadelupe and those that would be considered oil exploratory was the elimination of casing or risers connecting the hole to the vessel in some sort of a closed circulation setup.

Drilling Muds

Poor Mud Means Lower Pump Efficiency and Higher Drilling Costs. J. Marsee and R. J. Duran. *Oil Gas J. 59*, 129 (1961) June 12 (6 pp.)

Some of the muds frequently used today are cutting the volumetric efficiency of mud pumps. The result is often higher overall drilling cost. The loss of efficiency is sometimes unrecognized and tends to destroy confidence in the hydraulics calculations. The important point is to recognize what is taking place and to consider loss of volumetric efficiency in evaluating overall drilling costs. It is certain many times that the mud does prevent reducing overall drilling cost as a result of poor penetration rate associated with low pump efficiency.

Exploration

Hopes for "Big Oil" Lure Explorers. *Oil Gas J. 59*, 76 (1961) July 3 (3 pp.)

The geologically alluring Canadian Arctic islands, one of the world's untapped sedimentary areas, may be drilled before the year is out. The group, headed by Dome Petroleum, Ltd., Calgary, hopes to stake a location this fall. The top priority is expected to go to Dome's Melville Island acreage. An alternative site is the Bathurst Island acreage of Dominion Explorers Ltd.

Spanish Sahara Offers Real Prospect for Oil. J. B. Carrier. *Oil Gas J. 59*, 182 (1961) July 3.

Spanish Sahara should be of intense interest to the oil industry because of its geological relationship to the other portions of the Sahara region. Some of the world's largest reserves are being developed in Algeria and Libya from structural basins and provinces that are genetically related to similar features in the Spanish Sahara. A reconnaissance field study conducted in the Spanish Sahara during the months of May, June, and July 1959, was made from a fixed-wing aircraft and helicopter, and was followed by an additional 8 weeks of ground conducted field work from field-based camps using Land Rover vehicles.

Canadians Pin High Hopes on Arctic Test. F. J. Gardner. *Oil Gas J. 59*, 181 (1961) July 3.

The drilling of the first wildcat, in the Arctic Island of North America, must rank right alongside Mohole as one of the most significant exploratory events of this or any other year. Near Winter Harbour, an anticline spans Dundas Peninsula completely in a northwest-southwest direction, and plunges into the waters of Viscount Melville Sound. Dome estimates a 13,000-ft sedimentary section for the area. Surface rocks are of Devonian Age, and the operator expects to bottom the hole in Silurian.

Logging

How to Get Full Value from Your Well-Surveying Dollars. W. B. Bleakley. *Oil Gas J. 59*, 106 (1961) June 12 (7 pp.)

A three-part discussion is presented on well logging. The purpose is to increase the return on the money spent on formation evaluation. First, use the logging method, or methods, that will give best results for particular well conditions and formation types. This done, the economic battle is half won. From what is learned in the second part of this series, a better interpretation of the next job will be possible, and some money may be "salvaged" from that already spent. True resistivity is needed for the best evaluation of conventional electric

logs, and lack of these data may cause the missing of good producing zones. Increased use of air and gas for drilling means that conventional tools and methods must give way to newer developments. Operators in cable-tool country will find comfort in the third part of the series with up-to-the-minute information on empty-hole logging.

Logging Empty Holes. C. G. Rodermund, R. P. Alger, and J. Tittman. *Oil Gas J. 59,* 119 (1961) June 12 (6 pp.)

When the borehole contains only a gas, specialized logging methods are needed to get quantitative information on porosity and saturation. The recent development of the density logging tool made it possible to prepare logging programs to suit all conditions involving wells drilled with air or gas.

Now—Get True Resistivities from Conventional Electric Logs. H. Guyod and J. A. Pranglin. *Oil Gas J. 59,* 113 (1961) June 12 (6 pp.)

Here's a new method that will salvage many conventional electric logs, and make correct interpretation possible. A method has been developed for determining the true resistivities of beds, and in many instances, the resistivities and extents of their invaded zones, from an electric log comprised of a 16-in. normal, a 64-in. normal, and an 18 ft 8-in. lateral. Data needed for preparing the charts were obtained with a resistivity analog computer.

Secondary Recovery

A Comparison of Propane and Carbon Dioxide Solvent Flooding Processes. L. W. Holm. *A.I.Ch.E. J. 7,* 179 (1961) June (6 pp.)

A laboratory investigation was conducted on oil displacement from porous media by use of either a slug of propane followed by gas or a slug of carbon dioxide followed by water. A comparison was made of the efficiencies of these two solvent flooding processes for petroleum reservoirs. The results of flooding experiments on cores and on scaled pattern models showed the effect, on oil recovery, of type of porous medium pore geometry, length to width ratio of flood pattern, fluid viscosities, and miscibility. Oil recoveries of from 60 to 80% of the original oil in place were obtained by these solvent flooding processes as compared with conventional waterflood recoveries of between 35 to 50% on the same cores and linear models. Furthermore, these recoveries were obtained with solvent slug sizes of 10 to 30% of a hydrocarbon pore volume, with less solvent being required as the length of the flood path increased.

Well Practice

You Can Engineer Cementing Operations to Eliminate Wasteful WOC Time. W. G. Bearden and R. D. Lane. *Oil Gas J. 59,* 104 (1961) July 3 (6 pp.)

A generous bonus in rig time awaits adoption of latest thinking about "waiting on cement" time. Usual WOC time is now about 24 hr. Recent field and laboratory tests show that 8 hr is usually enough. If cements are carefully chosen, they develop needed strength and thickening well within the 8 hr period.

4. GAS CONDITIONING AND LPG RECOVERY

Dehydration

Check These Points When Designing Knockout Drums. E. R. Niemeyer. *Petrol. Refiner 40,* 155 (1961) June (2 pp.)

Knockout drums are vessels especially designed to separate liquids from vapor. Most applications have been in the separation of water and oil from air or gas, the recovery of gas-oil drips from vacuum systems, the reduction of entrainment in compressor suctions, and interstages, and the elimination of liquid drips in gas transmission lines. Their continued use in these services is due to simplicity of design, high performance and lower costs compared to other separation methods.

Dehydration and Stripping of the Hassi R'Mel Gas. J. J. Brut. *Preprint Congres A.T.G.* (Association Technique de L'Industries du Gaz en France) (1961) 9 pp. (French text.)

The Hassi R'Mel plant is an example of the technique of dehydrating and stripping raw gas by means of pressure-release cold. The reserves available in the reservoir are sufficiently large in relation to the most optimistic production forecasts to make it certain that pressure at the well head will remain at a high level for a long time to come. The available drop between the pressure at the well head and the pipeline output pressure results in a temperature drop which is adequate to lower the dew-point of the gas to its contractual value. At Hassi R'Mel plant, this process offers the substantial advantages of simple operation and easy maintenance. Tests made on a pilot unit have enabled the equipment to be adapted to local conditions.

Let Glycols Help Inhibit Hydrate Formation. Pt. 1. J. L. Arnold and R. L. Pearce. *Oil Gas J. 59,* 92 (1961) June (4 pp.); **Pt. 2,** *Ibid 59,* 125 (1961) July 3 (4 pp.)

The use of glycols for hydrate inhibition is outlined in detail in the discussion. Material is included to help select the proper glycol, calculate injection rates, and determine minimum withdrawal concentrations. Also, glycol losses and maintenance factors are discussed along with case histories.

Dust Removal

Rating of Dust Collectors According to Dust Settling Velocities. W. C. L. Hemeon, G. F. Haines, and S. D. Puntureri. *J. Air Pollution Control Assoc. 11,* 264 (1961) June (4 pp.)

An apparatus and technique are described which make it possible for the first time to measure the inertial

quality of any dust for determination of its collectibility in various types of equipment where inertial forces predominate. It measures the distribution of settling velocities (analogous to the phrase "distribution of particle size") which might be described alternatively as the distribution of particle inertia; and because of the significance of these qualities can be said to measure the collectibility of the elements of a dust mixture.

Hydrogen Sulfide Removal

Desulfurization and Removal of Carbon Dioxide from Lacq Gas. R. Locatelli. *J. Ind. Gaz 85*, 256 (1961) June (8 pp. French text.)

It was in December 1951 that the National Society of Petroleum of Aquitaine discovered, during the blowout of the shaft of Lacq 3, a deposit of natural gas which due to its composition and physical characteristics, constituted one of the most unique gases in the world. The content of hydrogen sulfide (15.2%) and carbon dioxide (9.8%) did not allow either transport or use of the raw gas in the state in which it emerged from the well. An extensive purification was necessary to eliminate the acids, as well as the condensable hydrocarbons (5%), the presence of which could cause serious disturbances in the movement of gases inside the pipelines. However, the high content of H_2S resulted in the production of sulfur, of great interest to the economy, and the condensable hydrocarbons were also products of value. As a result of these purification measures, the important installations which constitute the works at Lacq, were built.

Hydrogen Sulfide Conversion. L. G. Massey (assigned to Universal Oil Products Co.) U. S. 2,984,548 (1961) May 16.

A method for purifying hydrogen gas is claimed, which comprises passing a mixture of major proportion of hydrogen and minor proportion of hydrogen sulfide over glowing tungsten filaments. The H_2S is broken into hydrogen and sulfur which can be separated as molten liquid sulfur.

Sulfur

Production of Sulfur. P. Urban (assigned to Universal Oil Products Co.) U. S. 2,987,379 (1961) June 6.

A process for production of sulfur from hydrogen sulfide or alkyl mercaptans is comprised of absorbing sulfur dioxide and hydrogen sulfide in an organic solvent and water. The solvent may be of limited miscibility with water—such as the higher mono- and dihydric alcohols and ketones and their mixtures with kerosine, which dissolve up to 40% by volume in water. The improvement comprises adding to the solvent an amine such as N,N-dialkyl aniline, or dialkylamines, and dialkanolamines, which cause formation of granular, easily settled sulfur. It may operate on gas streams at atmospheric temperatures and to above 600 psi pressures.

Steel Corrosion in Boiling K_2CO_3 Saturated with CO_2 and H_2S. D. Bienstock and J. H. Field. *Corrosion 17*, 337t (1961) July (3 pp.)

Corrosion rates of carbon and stainless steel were determined in boiling solutions of potassium carbonate saturated with carbon dioxide and hydrogen sulfide. Solutions saturated with carbon dioxide were highly corrosive to carbon steel and slightly corrosive to Type 304 and 347 stainless. Type 410 stainless behaved similarly to carbon steel. Monel was even more resistant to attack. The addition of only 0.3% of hydrogen sulfide to the carbon dioxide reduced corrosion rate of the carbon steel by 96%. Boiling solutions of carbonate saturated with hydrogen sulfide were non-corrosive.

5. NATURAL GAS TRANSMISSION

Automation

Automation in Gas Industry Operations: Pt. 4 of a Field Study in Depth: Colorado Interstate Gas Co. Texas Eastern Transmission Corp. K. Kridner. *Gas 37*, 105 (1961) July (7 pp.)

Although gas distribution companies have taken the lead in the use of high speed electronic computers for dispatching functions, transmission companies have presented the gas industry's greatest area for advance in the use of automation—predominantly in automation of compressor station facilities. Currently there are two different types of equipment being utilized in such automated systems. There are solid-state systems incorporating diodes and rectifiers in their circuitry for an increased speed of operation; and the electromechanical systems using relays with their extensive background of dependability and experience, but having a slower closure time. It would appear that the principal difference between the two systems is in the speed of operation, since to date both have displayed excellent dependability.

Remote Control of McArthur Compressor Station. R. Lishka and D. H. Whiston. *Gas 37*, 93 (1961) July (5 pp.)

The automatic dispatching and telemetering installation is described. Ohio Fuel Gas Co.'s McArthur compressor station is one of 33 compressor stations operated by Ohio Fuel to speed deliveries of natural gas to almost 797,500 retail customers in 515 communities in 56 Ohio counties. McArthur station is on the main central pipeline system, remote from major markets. Due to its location and type of operation, McArthur was conceived as being operative by remote control from Crawford station, 35 miles to the north, with a manual change from "storage in" to "storage out" in spring and fall.

Compressor Stations

Trunkline Solves Vibration Problem. L. C. Sullivan. *Pipeline Ind. 14*, 65 (1961) June (3 pp.)

New compressor cylinder designs have eliminated all major vibration in suction and discharge piping adjacent

to the compressor cylinders on a new engine-compressor unit installed at one of Trunkline Gas Co.'s stations. Trunkline engineers had worked out the design changes in theory; and when the company placed a new 3000 hp unit in service at its Longville, La., compressor station last year their designs were proved out.

Fluid Flow

Designing Laminar-Flow Systems. Part 1. R. L. Bowen. *Chem. Eng. 68,* 243 (1961) June 12 (6 pp.)

In a new method for pipeline scaleup, a flow diagram is presented, derived from viscosity data. A complete set of pipe-flow curves is only one brief step further for various pipe sizes. No trial and error methods are required, and the resulting curves indicate how variations in pipe size, pressure drop, and flow rate affect each other. In the first part of a series on non-Newtonian-flow scaleup, problems and techniques for handling laminar flow are discussed. Further articles will take up turbulent flow and how to obtain data.

Expansion Coefficients for Orifice Meters in Pipes Less than One Inch in Diameter. G. A. Marxman and H. Burlage. *Am. Soc. Mech. Eng. Trans., J. Basic Eng. 83,* 289 (1961) June (10 pp.)

A practical technique for using orifices to meter most gases of engineering interest is described. This technique can be employed in pipes less than 1 in. ID, as well as in larger sizes. An analytical expression for the orifice expansion coefficient is developed; this expression includes an empirical factor based on published data for orifice installations in pipes two or more in. in diameter. Experimental verification has shown that the equation gives correct results for the smaller systems and in gases with a specific heat ratio other than 1.3 or 1.4. It is also shown that the empirical equation of orifice expansion coefficients which appears in the *ASME Fluid Meters Report, Pt. 1* can be used over a range that includes most gases as well as pipe diameters as small as ¼ in.

Flow Measurement for Accounting Purposes. D. D. Livingstone. *Am. Soc. Mech. Eng. Trans., J. Basic Eng. 83,* 299 (1961) June (6 pp.)

This paper discusses the industrial measurement of gases and liquids by means of thin-plate orifices. Installation and maintenance practices which reduce measurement errors are described. Records of flows for 21 streams are analyzed to estimate the accuracy of the metering.

Gas Tracer Method of Steady and Pulsating-Flow Measurement. J. F. Kemp. *Am. Soc. Mech. Eng. Trans., J. Basic Eng. 83,* 305 (1961) June (7 pp.)

A method is described of measuring the bulk mass-flow in steady and pulsating air streams with the aid of a suitable tracer gas such as CO_2. The method briefly involves controlled injection of the tracer into the main flow, mixing of the 2 flow media, and analysis of the mixture to determine the concentration of the tracer. The main flow is derived from the injection flow rate and from the concentration of the tracer in the sample mixture. An inexpensive infrared analyzer was constructed to determine mass concentrations of CO_2 in air ranging from ½ to 3%. Results obtained by the gas-tracer method in both steady and pulsating streams were compared with those obtained by other mass-flow measurement. A few possible practical applications of the measuring technique are discussed.

Thermodynamic Analysis of the Darcy Law. R. G. Mokadam. *Trans. ASME. J. Appl. Mech. 28,* 208 (1961) June (5 pp.)

The Darcy law is used extensively to describe the flow of fluids through porous media. According to this law the fluid flow is linearly dependent upon the pressure gradient and the gravitational force. The proportionality factor is generally known as the permeability of the porous medium. The Darcy law cannot be derived from the Navier-Stokes equation since this equation includes terms which characterize the fluid only. With the help of nonreversible thermodynamics it is possible to develop a general equation of the motion of a fluid through a porous body, and obtain the Darcy law as a special case of such an equation.

Theoretical and Experimental Studies on the Vortex Tube. M. Suzuki. *Inst. Phys. Chem. Res., Sci. Papers, Tokyo. 54,* 43 (1960) Mar. (45 pp. English text.) [From *Appl. Mech. Rev. 14,* 483 (1961) June.]

Vortex tube is a device which utilizes the centrifugal force produced by the vortex motion in a cylindrical tube. Flow of gases is three dimensional, moving in the axial and radial directions with vortex motion. It is very difficult to carry out a theoretical analysis. Therefore, setting up some bold assumptions concerning the velocity profile, approximate analyses have been attempted from the aerodynamic, thermodynamic, and acoustic standpoints. Results obtained are found to agree quantitatively with experiments.

From author's summary by M. S. Uberoi

Dynamics of Solid-Liquid Fluidization. S. H. Bransom and S. Pendse. *Ind. Eng. Chem. 53,* 575 (1961) July (2 pp.)

Experimental data for liquid-solid fluidized systems are correlated with modifications of the drag-force Reynolds number relationship for single fixed particles and with a modified form of the Karman-Kozney equation for fixed beds. Working equations have been derived from the curves of the data available. The porosity, bed height, minimum fluidizing velocity, etc., can be calculated generally to better than 10%, from the relevant characteristics of a system.

Gas Turbines

Better Bets in Turbines. *Business Week,* 89 (1961) June 17 (3 pp.)

The chief engineer of Garrett Corporation's AiResearch Manufacturing Division of Arizona, the leading producer of nonaircraft gas turbine engines, predicted that a "second generation" of small gas turbines was just around the corner. These dream engines, he said, would drink only 0.6 to 0.7 lb of fuel per horsepower hour, develop 1 hp per 0.7 lb of engine weight, and stand up 5000 hours between major overhauls. On the surface,

the gas turbine looks like an ideal power plant. The engine is small, and its simple design should mean less maintenance. It produces more power per pound of engine weight than anything but a pure rocket. Despite these virtues, the small turbine isn't exactly sewing up the market. The cost is too high. A 200-hp turbine may run to $20,000. The problem is that a turbine, rotating as rapidly as it does, requires extreme precision and special high-temperature metals. Blades on each turbine must also be individually machined.

Pipeline Construction

New Concept of Aerial Surveying Provides Complete Recon Pipeline Reports in Less than 30 Days. W. H. Scott. *Pipeline News 33,* 22 (1961) June (5 pp.)

For the first time a route for a natural gas pipeline has been surveyed by aerial photogrammetry without any visits to the site by ground crews. The lack of bulky ground crew procedure allowed for faster time schedules. The 80 miles of pipeline route, from Duluth to Silver Bay, were photographed from the air in 2 days, and the entire 80 miles were surveyed in approximately 3 weeks. On-the-ground techniques would have necessitated many survey crews, working many months.

PLGS (Pacific Lighting Gas Supply) Goes Under the Colorado River. M. E. Fuller. *Gas 37,* 100 (1961) July (5 pp.)

Selecting a crossing site about 20 mi upstream of Topock, the pipeline could cross a controlled section of the river. At that location, a channel having a radius of 9000 ft had been dredged and levees constructed for a normal channel 450 ft wide. A flood plain and second levee on the Arizona side made a second channel approximately 1000 ft wide. To meet criteria for a buried crossing, it was necessary with 24-in. OD x 0.625-in. wall pipe to apply a 2-in. minimum to a 2½ in. maximum coating thickness of wire mesh reinforced standard weight aggregate concrete. The use of relatively heavy wall pipe is felt desirable because it contributes to both strength and a corrosion allowance, while reducing the amount of concrete coating needed. Because of unsuitable conditions for curing concrete at the site, the pipe was to be coated in 40-ft lengths in a yard at Los Angeles.

The Bridge That Began Life Underwater. T. J. Miller, *Am. Gas J. 188,* 30 (1961) July (4 pp.)

The Zug Island Bridge, is part of a 4¼ mi, 22 and 24 in. natural gas line built to increase fuel supplies to Great Lakes Steel Corp. The line, part of a 1.3 million dollar project, was designed to carry gas from the company's River Rouge Station, located in southwest Detroit to Great Lakes Steel facilities on the banks of the Detroit River. The center span is a box truss structure, 220 ft long, consisting of 22 sections, each section being 10 ft long by 11 ft high by 12 ft wide. The center span is designed to support the existing 16-in. gas line, 2 future 10-in. gas lines, the future 24-in. Great Lakes Steel gas line plus 2 existing and one future walk-ways. Existing and future pipelines and walk-ways are or will be placed on the bottom chord of the center span.

Pipeline Operations

Trunkline Reports on Low-Cost Sandblasting That Increases Gas Flow. Part 2. A. W. McAnneny and L. C. Sullivan. *Pipeline Ind. 14,* 54 (1961) June (7 pp.)

In the concluding installment (for part I, see *Gas Abstracts 17,* 105) test results on the 4-in. line and the extrapolation of data to a 26-in. line indicated that such a line could be satisfactorily sandblasted and that improvements in transmission factors in the order of 10 to 16% could be reasonably anticipated. In view of these studies, the decision was made to sandblast a 7.9-mile section of 26-in. pipe. The section selected was an unusually straight and level line in the Mississippi Delta. It had a relatively low transmission factor of about 19.5 at a flow of about 400 MMSCFD, or a Reynolds number of about 16 million. This corresponds to an "E" factor of about 86% using the Panhandle A flow equation.

Walking the Line at 100 Mph. R. Lewis. *Pipeline News 33,* 16 (1961) June (3 pp.)

Aerial patrol proves most satisfactory survey method on Kerr-McGee's System. Kerr-McGee Oil Industries, Inc., Oklahoma City uses Aerial Patrol Service Corp.'s contract services in the eastern section of Oklahoma. Kerr-McGee has approximately 3000 miles of various size pipelines in this area to be checked at regular intervals. An experienced patrol pilot, clipping along at near treetop level, can cover several hundred miles of right-of-way in one day. With the price of gas, crude, or petroleum products at present levels, immediate location of a leak and quick repair can easily offset any higher costs caused by use of expensive aircraft.

Pressure Measurement

Precision Pressure Gauges. *Instruments and Control Systems 34,* 1057 (1961) June (7 pp.)

Precision test gages now can be used instead of deadweight testers where accuracy of 0.1 to 0.5% is required. Available precision test gages of the bourdon and capsule type and their many unique features are described.

Telemetering

Telemetric Control and Communication. G. A. Haninger. *Instruments and Control Systems 34,* 1071 (1961) June (6 pp.)

Discussions are given on costs to telemeter information, cost to include control functions, annual leased line costs, equipment costs, possibilities of expansion, growth of systems, flexibility, and other factors influencing the design of telemetric controls.

Remote Reading of Industrial Gas Meters. H. Schimmel. *Gas 37,* 58 (1961) July (3 pp.)

Northern Illinois Gas Co. has 58 large industrial customers whose meters are read daily, including Saturdays and Sundays. These meters are distributed over a wide geographic area, and under present methods the cost per meter read is rather high. Also other applications for this

type of system seem feasible; i. e., dialing unattended stations for information on pressures, temperatures, valve positions, etc. Therefore, in order to obtain operating experence, it was decided to proceed with an experimental installation. The system as now conceived will consist of a central receiver located at NIG offices and 58 remote transmitters located at customer installations. At the receiving station the equipment consists of a regular dial phone, a Data-Phone 401B receiver, a Telemation receiver-decoder, and a serial entry electric printer.

6. GAS AND LPG STORAGE

Gas Holders

Spiraled Gasholder with Pre-stressed Reinforced Concrete Basin in Berlin-Charlottenburg. W. Schmidt. *Gas- und Wasserfach 102,* 509 (1961) May 19 (6 pp. German text.)

After approximately 2 years of construction work, a spiraled 4-lift gasholder of 200,000 cu m (7MMCF) capacity was put into operation at Berlin-Charlottenburg in early 1961. The reasons which led to choice of this type of holder and to the construction of the water basin in reinforced concrete have been explained. After a brief illustration of the necessary earth and foundation work, the author gives details of the design and execution of the concrete basin. The technique employed and the materials used have been specified. The test of the water-tightness of the basin and the design and erection of the lifting equipment and other accessories of the holder are dealt with. One control station serves for accommodating all valves, fittings, measure and control gear. The author also describes startup of the unit after carrying out tightness tests and repeated trial runs.

Methane Liquefaction

Cold Liquid Storage Tank. J. A. Murphy (assigned to Conch International Methane, Ltd.) U. S. 2,986,011 (1961) May 30.

An improved tank construction is claimed for the storage and handling of cold liquids (methane), which provides a large insulated tank in a rigid supporting structure, with a central well extending downward, and sealed to roof and floor of the tank. The well is insulated to permit installation of pumps and motors at the bottom, and is also insulated from outer tank walls and supports. Thus the well provides medium temperature space for handling, and access space for repairs.

Insulation Space and Panels for Use in Same. J. A. Murphy (assigned to Conch International Methane, Ltd.) U. S. 2,983,401 (1961) May 8.

In storage and transportation of liquefied gas in large volume and in tanks of large capacity, maintenance of the liquefied gas at extremely low temperature (—240° F) presents a number of problems from the standpoint of structure and insulation. In this invention the supporting walls of the insulated space consist of a number of prefabricated, modular insulation panels having inner and outer face sheets with a thick layer of insulation. Mounting the panels on the supporting wall is done in an end-to-end and side-by-side relation to completely cover the wall. A metal face sheet provides an inner facing on individual panels in a slidable relation, allowing movement between panels in expansion and contraction. Joined in a sealable relation, the linear edge portions of the metal face sheets of adjacent panels are separated by a bulbous portion to permit relative movement.

Means for the Storage and Transportation of a Liquefied Gas. J. J. Henry (assigned to Conch International Methane, Ltd.) U. S. 2,983,409 (1961) May 9.

An inlet and outlet are provided for introduction of a discharge of liquid from a storage tank. Tubing extends downward to the bottom portion of the tank, and a pump transfers liquid through the tubing to the outlet. A liquid header receives discharged liquid and a sealed compartment within the bottom portion contains a supply of pressurized gas. A second opening in the compartment is provided with a pressure-responsive valve which closes when pressure builds up in the compartment and opens when pressure is lost. The liquid is forced from the compartment of the liquid header and is shiftable to another position to communicate the first opening with the vapor header. The pressure in the compartment is relieved and the pressure responsive valve opens to enable liquid to flow from the tank into the compartment.

Method and Means for the Transportation of Liquefied Natural Gas. C. M. Sliepcevich (assigned to Conch International Methane Ltd.) U. S. 2,984,080 (1961) May 16.

A method is claimed for minimizing the loss of liquefied natural gas through vaporization by mixing with liquefied nitrogen sufficient to last throughout the period of storage in the shipping tank. The liquefied nitrogen may make up to 20% by weight of the liquid in storage. The protection made available by such use is of particular importance during the return voyage since the released vapors will fill the available space in and around the tanks to provide a safe and inert atmosphere. It will also eliminate the necessity of purging the tanks to remove air, oxygen, and like materials which might form a combustible mixture with natural gas vapors.

The Experimental Natural Gas Liquefaction and Liquid Methane Storage and Regasification Station Set-up at Nantes. L. Richard and M. Biais. *Preprint, Congres A.T.G.* (Association Technique de L'Industrie du Gaz en France) (1961) 25 pp. (French text.)

Since 1954, Gaz de France has been studying problems connected with sea transportation of liquefied natural gas at −160°C (−256°F) at atmospheric pressure, which led to the establishment of a laboratory at Nantes. Their liquefaction plant is capable of producing 10,000 Nm^3 per 24 hr (372,200 SCF), the equivalent of about 17 m^3 of liquid gas (60 SCF). There is a capacity of 500 m^3 of liquid gas in the storage tank, corresponding to 290,000 Nm^3. Principal aims of the experimental study are:

storage tanks, regasification of liquid gas, very low temperature equipment, and the measuring and monitoring gear.

Natural Gas Liquefaction

Companies Push Plans for Liquefied Natural Gas. G. Weyermuller. *Chem. Processing 24,* 48 (1961) June (3 pp.)

Techniques and equipment used in every facet of industrial cryogenics will be aided by moves being made to invest $125 million now—with much more to come—in methane liquefaction plants, ships, and storage facilities. The Methane Pioneer may well be the forerunner of a fleet of ships to carry liquefied natural gas from areas such as the Middle East or Algeria, that have tremendous quantities of it, to countries that need it, such as England or Japan. The Pioneer made seven successful trips across the Atlantic from Louisiana to England. New ships to be built will each be about 4 times as large as the Pioneer.

In Atlanta, They Like Cold LPG Storage. F. Bennett. *Am. Gas J. 188,* 26 (1961) July (4 pp.)

Pioneer refrigerated LPG storage plant at Riverdale has been expanded to five times its original capacity; added production facilities now give Atlanta Gas Light 3430 MMCF peak shaving supply. Mixed gas delivery pressure has been increased to 200 psig and the production rate to 3430 MMCF per hr of natural gas equivalent. Propane, 6,450,000 gal stored in 5 tanks at 0.5 psig and −46°F, is sufficient for 8 days of operation at this production rate. Each of the 5 tanks was fabricated from A201, Grade B, aluminum-killed steel plates with butt joints full penetration welded from both sides and 100% X-rayed. The tanks have 70-ft diam cylindrical shells 40-ft high with flat bottom and domed self-supported roof.

Means and Method for Protection of Liquefied Gas Storage Tank. J. J. Henry (assigned to Conch International Methane, Ltd.) U. S. 2,986,892 (1961) June 6.

An insulated tank for storage of liquefied gas is claimed in which a safety indicator for the breakdown of insulation is featured. A vapor outlet line from the top of the tank with a measuring and recording device shows unusual increases in rate of gas evaporation due to loss of insulation. A separate safety outlet with safety relief valve is provided to vent pressure.

World's First Plant Designed to Provide Refrigerated LP-Gas for Tanker Shipment. *Gas Age 127,* 23 (1961) June 22 (2 pp.)

Special insulation techniques will permit holding LP gas at −43° temperatures against outside temperatures running as high as 120°F. The world's first plant specifically designed to make fully refrigerated liquefied petroleum gas available for tanker shipment is now under construction at Ras Tanura, Saudi Arabia. The $7 million plant, now being constructed by the Arabian American Oil Co., will supply 4000 bbl daily of high purity propane and butane or a blend of the two.

Storage Tanks

Purge Means for Storage Tank. S. Beckwith (assigned to Conch International Methane Ltd.) U. S. 2,986,010 (1961) May 30.

A safety storage method and tank for liquefied methane is claimed, in which a small compartment is sealed at the bottom of the tank and filled with solid carbon dioxide through a pipe leading to the tank roof. When liquid CH_4 is emptied from the tank, carbon dioxide evaporates from the solid and is released into the tank by pressure valves on the compartment and purges the tank through the roof vents.

Underground Storage

The Establishment of an Aquifer Storage (Part I). E. Diekmann. *Gas- und Wasserfach 102,* 641 (1961) June 9 (6 pp. German text); *Ibid,* 700 (1961) June 23 (7 pp.)

Installation of an underground storage facility is desirable near large cities at the ends of long pipe lines and near harbors. Because of meager knowledge of deeper earth layers suitable for gas storage, in general one must rely on older results of oil exploration. The Hahnlein storage project of Ruhrgas, now in its last phase of study, is an example of development of an aquifer storage. Electrolog tests of wells and reflection-seismographic measurement of the structures are described for this and other areas.

How the Mount Simon Gas-Storage Project Was Developed. W. M. Rzepczynski, D. L. Katz, M. R. Tek, and K. H. Coats. *Oil Gas J. 59,* 86 (1961) June 19 (6 pp.)

Continued need for gas storage capacity in the Chicago area led to the development of the Mount Simon gas storage reservoir, from that formation at Herscher field, Illinois. It underlies the Galesburg reservoir completed earlier as a gas storage aquifer. Details are given from first investigation to full scale operation.

A Report on Gas Storage in Underground Water Reservoirs. E. V. Martinson. *Pipeline Ind. 14,* 38 (1961) June (5 pp.)

Across the nation, the use of petroleum-barren anticlinal aquifers for underground gas storage has become extremely important to the natural gas industry. They appear to be the answer to the problem of creating economical large-volume gas storage where depleted oil and gas fields are nonexistent. The success of several large aquifer gas storage fields has proven them to be pioneers in the rapid development of a brand new segment of the natural gas industry.

Underground Storage of Fluids in Clay Beds. C. F. Teichmann and A. D. Garrison (assigned to Texaco Development Corp.) U. S. 2,983,103 (1961) May 9.

A method of forming an underground storage cavity for hydrocarbon storage in a deep clay formation is claimed, in which the usual well is drilled to formation level and concentric casing installed to provide a spray of deflocculating solution for loosening clay-laden slurry. After suitable enlargement of the cavity is attained, the

cavity walls are stabilized with sodium silicate and with solutions of flocculating agents such as alkaline chlorides, thiocyanates, chlorates, iodides, nitrates, etc. Such solutions are used to displace stored hydrocarbons.

Underground Storage of Liquid Methane: Theoretical Study; Laboratory and Pilot Plant Tests. J. Toche. *Preprint, Congres A.T.G.* (Association Technique de L'Industrie du Gaz en France) (1961) 22 pp. (French text.)

The underground storage of propane and butane in reservoirs artificially hollowed-out using underground working techniques has experienced wide development in the United States. Gaz de France, which is studying the sea transportation of liquid methane, decided to examine the possibilities offered by these underground reservoirs in order to establish the very large stockpiles required at the end of the transport link. However, storage of liquid at a temperature of −160°C was entirely new and many new problems had to be solved. The paper reviews current research.

Underground Storage of Natural Gas in Illinois. A. H. Bell. *Illinois State Geological Survey, Circular 318,* (1961) 27 pp.

Natural gas from the Mid-Continent and Gulf Coast regions is being stored underground in Illinois in 6 areas as of January 1, 1961, and similar storage projects are planned in at least 5 other areas. The storage reservoirs are of 2 main types: 1) "aquifers," or those that originally contained only water, and 2) those that contained oil or gas as well as water. Gas storage reservoirs now in use have an estimated total capacity of 184 billion CF.

7. MANUFACTURED GAS AND CHEMICAL PROCESSING

Acetylene

Hydrocarbon-Acetylene Capacity to Almost Double. *Oil Gas J. 59,* 149 (1961) June 12.

Four companies have announced plans in the past year for plants to produce 265 million pounds of acetylene per year from hydrocarbon feed stocks. This almost doubles the petrochemical-acetylene capacity of the United States. On the basis of 100 million-pound per year plant capacity, it is claimed that acetylene can be made for about 5 to 6 cents per pound, and certainly less than 10 cents, if offgases can be profitably used.

Production of Acetylene. J. L. Lauer and P. J. Friel (assigned to Sun Oil Co.) U. S. 2,986,505 (1961) May 30.

A process for the production of acetylene comprises subjecting a gaseous hydrocarbon charge stock, essentially methane, confined in a closed reactor to a series of discontinuous d-c electric spark discharges. Simultaneously, a series of magnetically-driven shock waves are applied of sufficient intensity to enhance the production of acetylene.

Aromatics

Benzene from Toluene by Detol Process. *Petrol. Refiner 40,* 228 (1961) June.

Now through a new catalytic hydrodealkylation process it is possible to produce close to theoretical yields of benzene from toluene and xylenes. This process is highly selective and may be used for dealkylating either pure toluene and xylenes or those containing paraffins, olefins, and sulfur compounds (such as thiophene). The impurities are converted to light hydrocarbons and hydrogen sulfide.

Catalysts

Effectiveness Factors for Porous Catalysts. J. O. Mingle and J. M. Smith. *A.I.Ch.E.J. 7,* 243 (1961) June (7 pp.)

From the equations expressing mass and energy transfer in the solid and void regions of a catalyst of micropores, conversion and temperature profiles are evaluated as a function of the properties of the particle and the reaction system. The method developed is illustrated with numerical calculations for a first-order, irreversible reaction. Microeffectiveness factors E_c are derived from these profiles for several distribution functions for the size (radius) of the micropores. The results indicate that the nature of the pore-size distribution cannot affect E_c more than about 10%. However, effectiveness factors greater than unity are possible for exothermic reactions with high heats of reaction and particles of reasonable size. To treat pelleted catalysts, equations are also developed for determining conversion temperature profiles in pellets formed by compressing the microporous particles.

The Effect of the Support on the Infrared Spectra of Carbon Monoxide Adsorbed on Nickel. C. E. O'Neill and D. J. C. Yates. *J. Phys. Chem. 65,* 901 (1961) June (6 pp.)

An experimental study has been made of the effect of the support in changing the adsorption characteristics of carbon monoxide on nickel supported on alumina, silica, and titania. These changes have been determined by the effects produced on infrared spectra of chemisorbed carbon monoxide. The new cell has been developed with sealed-on magnesium oxide windows, usable to at least 8 μ, and has a small volume. The whole cell can be heated to 400°C (752°F) while evacuating the sample. The sample can be moved out of the optical path without affecting the sample conditions. Carbon monoxide adsorbs on the nickel surfaces in two forms. In one species, CO is attached to one nickel atom (linear), while in the other the molecule is attached to two nickel atoms (bridged). A marked variation was found, as the support was changed, both in the strength of adsorption, and in the relative numbers of the two species. In general alumina and titania have marked effects on the adsorption of CO on supported nickel. Silica seems to have little, or no, effect.

Presorption of Carbon Monoxide and Hydrogen on a Cobalt (Fischer-Tropsch) and a Zinc Chromite (Methanol) Catalyst. N. C. Ganguli, K. A. Kini, and N. G. Basak. *J. Sci. Ind. Res. 20D,* 216 (1961) No. 6 (3 pp.)

The effect of presorption of carbon monoxide on the adsorption of hydrogen and vice versa on a cobalt catalyst used in Fischer-Tropsch synthesis and also a zinc chromite catalyst used in methanol synthesis has been studied. It has been found that with the Fischer-Tropsch catalyst, the presorption of large quantities of carbon monoxide suppresses the adsorption of hydrogen, and that of smaller quantities enhances it and vice-versa. In the case of methanol catalyst it has been observed that the adsorption of hydrogen is enhanced with the prior adsorption of larger quantities of carbon monoxide.

Coal Carbonization

Technical Modernization of Coke Ovens and Coal and Coke Handling Equipment at Kattwyk Plant of Hamburg Gas-Works GmbH (Part I). G. Duwel. *Gas- und Wasserfach 102*, 653 (1961) June 9 (8 pp. German text); **(Part II).** *Ibid*, 694 (1961) June 23 (6 pp.)

Hamburg, which is the largest gas undertaking in Germany, obtains gas from 2 coke oven plants—9170 MMCF/year from Kattwyk, 8855 MMCF from Grasbrook; natural gas reforming 770 MMCF, and refinery gas reforming 3500 MMCF. Kattwyk, built in 1958-60, comprises 88 regenerative "Kreisstrom" ovens in 4 batteries located on a harbor peninsula with exceptional facilities for storage, handling, and water transport by ocean or river.

Coal Gasification

Apparatus for Degasifying Finely Divided Fuels. F. Danulat and P. Schmalfield (assigned to Metallgesellschaft A.G.) U. S. 2,983,653 (1961) May 9.

Finely divided solid fuels are degasified in a vessel and are heated directly with hot, finely divided heat carriers (coke particles). A mixing chamber is provided with two mixing worms rotating in the same direction, and acting to clean one another. The heated subdivided heat carriers, screened out at the product end of the heating chamber, are recycled to the inlet of the mixing chamber where they meet a measured stream of fine raw coal. The coke may be burned with air in the product chamber to reheat the heat carriers, and the evolved gases and volatiles are removed from the mixing chamber.

Westfield First Lurgi Pressure Gasification Plant in Britain. *Gas Times 95*, 15 (1961) June (6 pp.); **The Westfield Lurgi Plant.** *Coke and Gas 23*, 219 (1961) June.

The works at Westfield, Fife, which are being built by the Scottish Gas Board at a cost of about $20 million with a further $5 million to be spent on a high-pressure pipeline system, now produce 15 MMCF of gas per day. The plant has been built adjacent to the workings of the Opencast Executive of the National Coal Board, so that adequate supplies of coal will be available to the works for a period of either 20 years or during the life of the opencast workings (strip mining)—whichever is longest. Westfield is the first gasworks in that country to use oxygen on a large scale for the production of town gas. The system adopted operates on the air separation principle and is of the liquid-pump type. This type provides liquid oxygen at a temperature of —183°C. vaporization of the liquid oxygen takes place in a heat exchanger after which it is preheated and passed to the Lurgi gasifier as gaseous oxygen at the required pressure.

Hydrocarbon Synthesis

Synthesis of Hydrocarbons from Carbon Monoxide and Steam. Part VIII. Synthesis on Nickel Catalysts. H. Kolbel and J. Gaube. *Brennstoff-Chemie 42*, 149 (1961) May (5 pp. German text.)

Optimum reaction conditions were found for the synthesis of hydrocarbons and oxygen-bearing compounds from CO and H_2O according to Kobel and Engelhardt on nickel. The dependence of the reaction velocity on partial pressure occurs in similar manner as on iron and cobalt catalysts as in the equation $r = k_1 p_{H_2O} + k_2 p_{H_2}$. By comparison of the equation constants for iron, cobalt, and nickel, the peculiarities of these catalysts were explained.

Hydrogen

Preparation of Liquid Hydrogen. K. C. Smith (assigned to British Oxygen Company, Ltd.) U. S. 2,983,585 (1961) May 9.

A process is claimed for the production of liquid hydrogen, which includes the partial combustion of gaseous methane with oxygen and the conversion of associated product carbon monoxide into carbon dioxide and fts removal. The remaining crude hydrogen is highly compressed, cooled by heat exchange with liquid methane, and further cooled by indirect transfer with stored liquid methane. The vaporized methane is used in the combustion stage. The cold hydrogen is purified and part of it expanded to provide cooling to liquefy the remaining hydrogen.

Hydrogen Cyanide

Preparation of HCN and Acetylene. P. J. Friel and J. L. Lauer (assigned to Sun Oil Co.) U. S. 2,986,506 (1961) May 30.

A process for the production of hydrogen cyanide and acetylene is claimed which comprises subjecting a gaseous charge stock comprised of methane and nitrogen confined in a closed reactor to a series of discontinuous direct current electric spark discharges. Simultaneously a series of magnetically-driven shock waves are applied, of sufficient intensity to enhance the production of hydrogen cyanide and acetylene.

Mixed Gas

Controlled Butane Injection. *Petrol. Times 65*, 347 (1961) May 19.

A key factor in the production of gas by the Lurgi process, in which complete gasification takes place, is the adjustment of the gas calorific value to the required minimum before pumping to the mains. The new plant at Westfield in Scotland operates on the Lurgi process. The capacity on completion will be around 30 MMCF

per day, or equivalent to 20% of Scotland's total requirements. Since the calorific value of the plants entire gas output depends on the accuracy and reliability of the butane feed pumps, the specification for these was necessarily demanding. Butane is pumped from a storage tank which is held at ambient temperature; the butane is allowed to boil, finding its own pressure corresponding to the ambient temperature. The feed capacity has to be steplessly variable from zero to 950 gallons per hour, the set rate being maintained exactly.

Oil Gas

Problems of Process Technology and How They Are Solved in Gasworks. M. Raschig. *Gas- und Wasserfach 102,* 526 (1961) May 19 (6 pp. German text.)

From the variety of technological problems in the gas industry, two complex fields have been selected: gas production from mineral oil products and washing out of undesirable gas components. The author shows the interrelationships between the design of cracking processes and the feedstock intended to be cracked. Several processes are cited and specific solutions regarding their particular process technology have been pointed out. On the subject of gas washing, some special questions of ammonia and hydrogen sulfide removal have been discussed. In addition to the processes proper, a number of washer designs have been treated and data given concerning their load ranges, pressure losses, and selectivity.

Ore Reduction

Production of Iron from Ferrous Slag Materials. A. F. Johnson (assigned to Strategic Materials Corp.) U. S. 2,986,458 (1961) May 30.

A process is claimed for production of iron from iron silicate slag, which comprises blowing a hydrocarbon gas (methane) and pulverized lime into molten high-iron slag held above a pool of molten iron. The gas is preheated to 200°C and the lime to 700°C. The process may be used in a blast furnace charged with siliceous iron ore. Gas above stoichiometric amounts may be used and separate air supply injected for heating.

Petrochemicals

Conversion of Cyclopentadiene into New Bicyclopentyl Derivatives; Structure Determination with the Help of Proton Magnetic Resonance Spectroscopy. C. F. Blakely, R. J. Gillespie, L. Roubinek, A. Wassermann, and R. F. M. White. *J. Chem. Soc.,* 1939 (1961) May (7 pp.)

Cyclopentadiene and trichloroacetic acid react, under specified conditions of concentration, to produce the trichloroacetate (I) of a new alcohol (II) containing two conjugated double bonds. Both the ester and the alcohol are unusually reactive and can be converted into novel polymers. Catalytic hydrogenation of the alcohol (II) gives 3-cyclopentylcyclopentanol which has been converted into 3-cyclopentylcyclopentanone, cyclopentylcyclopentenes, and bicyclopentyl. Proton magnetic resonance spectroscopy in conjunction with the above observations shows that the alcohol (II) is 3-(cyclopenta-2,4-dienyl)cyclopentanol.

New Markets Revive Petrochemical Propylene Oxide and Glycol. P. W. Sherwood. *World Petrol. 32,* 66 (1961) June (5 pp.)

In a period when the upward trend in the sale of many petrochemicals appears to have diminished considerably, propylene oxide offers a remarkably bright outlook for expansion. Output rose from 105 million lb in 1957 to 288 million lb in 1959, is expected to spurt to reach 300 million lb in 1960, and continue at a growth rate of 5% per year. Some of 1959's remarkable upsurge seems to be due to inventory adjustments but much of it represents a real increase in consumption. Recovery of propylene oxide markets since then may be credited to the rapid development of two new end-use areas: (1) polyester resins, hydraulic fluids, fatty acid esters, and a number of lesser products based on propylene glycol, and (2) polyethers (principally polyurethanes), based on propylene oxide—a particularly rapid growth field.

Phenol

What are the Processes and Prospects for Phenol? J. Gordon. *Petrol. Refiner 40,* 193 (1961) June (14 pp.)

Four established routes compete and growth patterns shift as new processes coming into the field make phenol more petrochemical. More need for phenol and more processes for its manufacture are pushing it steadily towards the center of the petrochemical arena. Starting with the advent of the cumene phenol process about seven years ago, the trend largely reflects its growing acceptance in competition with three other, longer established processes.

Pyrolysis

Some Kinetics of the Carbonization of Benzene, Acetylene, and Diacetylene at 1200°C. R. S. Slysh and C. R. Kinney. *J. Phys. Chem. 65,* 1044 (1961) June (2 pp.)

The results of the investigation show that benzene decomposition is first order at 1200°C. Of the products diacetylene also decomposes by first-order kinetics, but acetylene decomposes at an accelerating rate suggesting that a decomposition product, possibly carbon, affects the rate in a marked manner.

Reformed Gas

Process for Producing a Fuel Gas. L. C. Bearer (assigned to Phillips Petroleum Co.) U. S. 2,985,525 (1961) May 23.

Conventional-type pebble heater apparatus includes two refractory lined contacting chambers disposed one above the other and connected by a refractory lined pebble throat of relatively narrow cross section. Refractory solids of flowable size and form are passed continuously and contiguously through the system, flowing by gravity through the entire length of the system and then conveyed to the top of the system to complete the cycle. A continuous method of forming fuel gases consists of heating the pebbles to incandescence—1900 to 2050°F by injecting hydrocarbon in such a pebble zone and gravitating them directly through the lower reaction zone. The pebbles in the reaction zone have coke

formed on their surface, and steam is introduced into the lower portion of the reaction zone, converting some of the carbon to water gas. These products are forced to the upper portion of the reaction zone and directly to and through the quench zone. Cool pebbles pass through the quench zone and absorb the heat thus released.

Shale Oil

Method and Apparatus for Stripping Oil from Shale. T. D. Nevens, R. A. Fisher, and W. J. Culbertson, Jr. (assigned to the Oil Shale Corp.) U. S. 2,984,602 (1961) May 16.

A process for pyrolysis of oil shale consists of completely pyrolyzing fresh coarse ground shale by intermixing with large inert, heat-carrying balls at 900° to 1100°F in a rotary cylindrical kiln. The pyrolyzed coked particles are ground to a powder which is readily screened out and passed to a combustion vessel to be fluidized and burned with air. The cooled, inert balls are then contacted directly with the fluidized shale gases, and ash at 1100° to 1600°F and are reheated and recycled to the kiln. The settled shale gas and gas may be used to preheat combustion air or steam.

Synthesis Gas

Generation of Carbon Monoxide and Hydrogen from a Liquid Hydrocarbon. D. B. Eastman (assigned to Texaco, Inc.) U. S. 2,976,135 (1961) Mar. 21.

In a process for producing carbon monoxide and hydrogen by partial combustion with 0_2 and steam from a crude or residual oil containing vanadium or nickel, an improvement is claimed which comprises adjusting reactants to liberate from 0.5 to 10.0% carbon as a solid during the reaction. Such carbon formation retains the bulk of ash-forming metals and prevents slagging and destruction of generation refractories at the reaction temperature.

8. GAS DISTRIBUTION

Distribution Systems

Supervision, Telemetering, and Control of Unattended Gasholder Stations Over the Public Telephone Systems. C. R. P. Stonor. *Gas J. 306,* 369 (1961) June 7 (4 pp.)

A careful analysis of the basic information required by the control room should be made in order to reduce the complexity of the supervisory equipment, thus improving the capital cost factor. The amount and accuracy of the information should be the minimum to assure effective action in the control room. The commitment cost of a supervisory system should be carefully assessed in relation to its capital value and efforts made to keep it at a minimum. Low maintenance costs can be achieved by standardization of plug-in units and the elimination of periodic inspections, and the cheapest transmission medium should be used. There are three Datafonic systems: Mark I provides supervisory information in a series of verbal statements; Mark II, on telemetered dials and indicator lamps; and Mark III, combining the Mark I and Mark II, provides information in a verbal form.

Fluid Flow

Load Measurement and Its Application in Determining the Widths of Gas Piping. R. Brandt and H. Ufer. *Gas- und Wasserfach 102,* 515 (1961) May 19 (9 pp. German text.)

The determination of internal gas pipe widths has so far been made according to the well-known flow tables without considering the actual load value. The authors have tried to determine mathematical relations for the true load value (Q_n) on the basis of experimental investigations into residential connecting lines, considering the number of apartments, the connected load, and the specific uses of gas. The calculated and measured values have been compared in tables. Several examples serve to explain the application of formulas for the determination of the true load value (Q_n). For easier use, some tables have been added showing Q_n and permissible gas flow for connecting and distribution lines of various nominal widths.

Leakage

Gas Leak Detection by Dogs. Ir. J. van Dam van Isselt and Ir. J. G. de Voogd. International Gas Union *IGU/33—61. 8th International Gas Conference,* Stockholm (1961) 14 pp.

After a brief review of the most important articles which have been published since 1955, the limited literature dealing with the use of trained dogs is discussed. Subsequently, the experienced gained in the Netherlands with two dogs trained for this purpose is given. Selection and training of the dog are of paramount importance, and the leader and the dog should be well matched. The change-over from training to actual practice generally does not present great difficultes. The "dog"-method offers the advantages of swiftness, reliability and cheapness. There are some disadvantages that are nearly all connected with the fact that living beings are involved. On account of the experience which the authors gained, they are of the opinion that the advantages more than counterbalance the disadvantages.

How to Make Gas Leakage Surveys for Only $5 Per Mile. P. S. Magruder, Jr. *Pipeline Ind. 14,* 43 (1961) June (4 pp.)

By using a super-sensitive sensing instrument— an infrared analyzer—mounted on a light pickup truck, Southern California Gas Co. has been able to conduct leakage surveys on its cross-country lines for about 0.1 cent per foot. This is one-tenth of the previous cost. Infrared is giving reasonably reliable results comparable to barring in open country and at a considerable savings. This method will probably not replace barring, particularly in leakage centering work or where heavy pavement is present; but recognizing its limitations and using judgment in its application, it has proven to be a sound investment.

Mechanism of Gas Filtration in a Three Layered Soil. V. A. Smirnov. *Inzhener, Sbornik Akad. Nauk SSSR 28,* 44 (1960) (7 pp. Russian text.) [From *Appl. Mech. Rev. 14,* 492 (1961) June.]

The problem of gas filtration through a sandwich construction consisting of materials of different physical characteristics has been studied. It was assumed that the "sandwich" consists of three-layered soil. Two cases have been studied: one in which penetration is partial, and one in which the layers consist of completely porous media. Using the potential function the equations describing the motion of gases through each layer are derived and solved, satisfying completely the boundary conditions. Reviewer is of the opinion that the paper represents a good contribution in the gas dynamic field, describing filtration phenomenology in such a porous system. M. M. Stanisic

Mains

New Low Pressure Machine Taps, Plugs, Completes. *Am. Gas J. 188,* 34 (1961) July (2 pp.)

A new approach to plugging operations when making hot taps on low and medium pressure gas distribution mains has been introduced. Named the *Shortstopp* by its developer, the device is designed to work at pressures up to 60 psi, using ASA 150-lb fittings welded to the line. Sizes from 2 to 12-in. are planned. The equipment, field tested by gas utilities in all sections of the nation, can be used to isolate a section of the line for repairs, extensions, replacement, or relocation of lines all without interrupting flow.

Metering

Advance Scheduling Gets the Work Done. A. D. Petersen. *Gas 37,* 44 (1961) July (5 pp.)

The changing pattern of PMC (periodic meter changing) work revealed in the 2 previous articles, necessitated a reappraisal of PMC planning, scheduling, and dispatching. The net result: reduced costs during a period of rising costs. A thorough study of the problem was made. Particular emphasis was given to 1) improving PMC planning and scheduling, and 2) developing standards of production. To accomplish the first objective, an analysis was made for each of 8 operating divisions—to determine the workload and manpower availability for each month of the year.

Odorants

Evaluation Procedure for Odor Control Methods. W. F. Kerka. *ASHRAE J. 3,* 49 (1961) July (9 pp.)

As part of the environmental program at the ASHRAE Research Laboratory, the study of air conditioning odors has achieved an important position—one which should give much-needed information to the design engineer. It is the purpose of this paper to examine a procedure which can be used to evaluate odor-control methods such as odor modification, sorption, and oxidation. The term modification will be used to imply either masking, counteraction, or cancellation.

Piping

Thin Wall Pipe: A Survey of Trends in the Gas Industry. E. H. Wood. *Gas 37,* 44 (1961) July (5 pp.)

Memphis Gas has benefited by the use of a limited quantity of pipe lighter than standard pipe in the 8 in size and larger. The approved use of this pipe was facilitated greatly by the publication, "Gas Transmission and Distribution Piping System (ASA B31.8-1958)". It was decided that a final decision could best be made with a knowledge of thin wall pipe experience of distribution companies around the nation. Questionnaires were sent to 28 gas distribution companies, asking for present and contemplated practices in regard to wall thicknesses. It is believed that trends revealed by this survey were reliable and representative of distribution companies throughout the nation.

9. GAS FUEL UTILIZATION AND APPLIANCES

Air Conditioning

Electric vs Gas Drive for Big Building Cooling. J. E. Norris. *Air Eng. 3,* 22 (1961) June (3 pp.)

An air conditioning installation added to the existing factory of Black and Decker Manufacturing Co., completed in mid-1960 is unique in its use of a single large natural gas-fueled internal combustion engine as the prime mover for a centrifugal compressor. It is believed to be the largest single gas engine unit for air conditioning in this country. A favorable summer gas rate for air conditioning allowed approximately $4500 annual saving in energy costs for the gas engine over electric motor drive; maintenance for the engine and other costs reduced this to about $2600 net. The refrigeration machine consists of a 776-ton centrifugal compressor driven at 8500 rpm by a V-12, 825-hp natural gas engine operating at 1100 rpm through a geared speed increaser.

How to Check the Load Against the Equipment. H. Olbur. *Gas Heat and Comfort Cooling 12,* 36 (1961) June (4 pp.)

The reason behind many mechanical failures is oversized or undersized air conditioning equipment. Unless the basic principles are known, the serviceman may be unable to perform efficiently. Mechanics often ignore such things as heat loss and heat gain, but for air conditioning, just knowing the principles of accurate heat gain measurement can lead a serviceman to causes of failures that would never be traced mechanically. Use of the ARI heat gain form for commercial cooling illustrated.

Air Pollution

Deposition of Aerosol Particles in Fibrous Filters. D. G. Thomas and C. E. Lappel. *A.I.Ch.E.J. 7,* 203 (1961) June (8 pp.)

The collection efficiency of glass fiber pads was investigated with a supercooled liquid aerosol. A filter-velocity range of 0.02 to 20 ft/sec was covered with

filter pads having a bulk density ranging from 1 to 10 lb/cu ft and a fiber diameter ranging from 1 to 30 μ. For the aerosol employed the results showed a minimum collection efficiency at a velocity of 2 to 5 ft/sec, dependent on fiber size. At the lower velocities, where diffusion is controlling, collection efficiency increased with decreased velocity; at higher velocities, where inertia is controlling, efficiency increased with increased velocity.

How Dust Filter Selection Depends on Electrostatics. E. R. Frederick. *Chem. Eng. 68,* 107 (1961) June 26 (8 pp.)

Electrostatic behavior of both dust and filter fabric, and their rate of charge dissipation, exert a profound effect on filter operation. Fabric filters for dust collection have been under development for many years, but the selection for any given job is still a perplexing and often costly task for the many industries that use them. However, several years of study have established the parameters that affect this selection and point up the fact that the electrostatic properties of both the dust and the collecting fabric are extremely critical in dictating filtration performance.

Burners

Gas Burner. G. A. Finley and G. W. Spieler (assigned to Finco, Inc.) U. S. 2,983,312 (1961) May 9.

An improvement is claimed for a burner for liquefied petroleum gases, which comprises a preheating coil wrapped around the port end of the burner tube to provide heat of vaporization for the fuel. The preheater is arranged to slide along the burner tube and may also carry a transverse baffle plate at a fixed distance beyond the burner port to aid in reflecting flame back upon the coil.

Swirl Burner. C. E. Golden. U. S. 2,985,234 (1961) May 23.

A swirl burner comprised of the usual orifice, air shutter, and mixing tube, but with turned-up burner parts, is formed in a disc-closure for the threaded burner-end. The disc is pierced by several spaced helical channels which impart the swirl to the gases. A damper disc, revolvable to close the helical port openings, is fastened by a bolt in a central conical depression in the port disc.

Clothes Dryers

Clothes Dryer Control. F. F. Heiser (assigned to Controls Co. of America) U. S. 2,984,298 (1961) May 16.

A control for a gas-fired clothes dryer consists of a circuit including a solenoid-operated main valve between the safety valve and main burner. A thermostat controls the main valve, and a means of resetting, including a thermocouple in electric circuit with an electromagnet holder connected to the safety valve, are provided. The reset when actuated opens a switch in the solenoid main valve circuit and prevents opening of the main valve. Circuits are provided to prevent operation of the safety except when the timer is operating.

Gas and Electric Automatic Clothes Dryers. *Consumer Repts. 26,* 445 (1961) Aug. (7 pp.)

Test results obtained in the largest clothes dryer project in Consumers Union history covered 40 models, both gas and electric, and represented 16 major brands. The comparison of high- and low-priced models was made principally among electric dryers, which out-sell gas dryers by something like two to one. On the basis of the tests for performance, convenience, and safety, five electric dryers were check-rated for high overall quality. All of the gas dryers tested had one or more deficiencies, judged sufficiently serious to preclude check-rating. Gas dryer operating costs in many localities are so much lower, that the price differential per load for the gas dryer may be as great as 8½¢; or on a monthly basis $2.73 may be added to the electric bill as against 52¢ for the gas consumption.

Cookers

Gas Broiler with Heat Shutter Device. I. Nevin and A. I. Fader. U. S. 2,985,097 (1961) May 23.

A gas broiler is claimed comprising a casing with burners near the top, supporting a grate above the burners. The improvement consists of a heat shutter placed between burners and grate, composed of a number of parallel louver plates, each supported by a pivot at the sides of the casing and all such sloped plates, adjustable simultaneously by spaced pins in a sliding bar. The closing of the louvers gives more heat on the grate by shutting off air draft through the casing.

20 Questions on the Gas Cooker Market. C. T. Baker-Carr, S. A. King, F. M. Rogers, and R. A. Smith. *Gas Service and Domestic Coke 40,* 279 (1961) June (13 pp.)

For the first time sales of gas and electric cookers are approaching parity, and for this reason the gas cooker market must be recognized as being in a critical condition. What can be done to improve the gas cooker and methods of selling it? This feature, based on individual meetings between the Editor of *"Gas Service"* and senior executives of four major cooker manufacturers, seeks to explore current thought among the makers on aspects of cooker design and construction and on ways in which the gas industry can hold and increase cooker sales.

Flame Research

Rate of Reaction, $O + H_2 \rightarrow OH + H$, in Flames, C. P. Fenimore and G. W. Jones. *J. Phys. Chem. 65,* 993 (1961) June (3 pp.)

By probing low pressure flames of H_2—O_2—N_2—N_2O, and using the ratios of rate constants previously determined in flames, the rate constant for the reaction of oxygen atoms with hydrogen molecules is found to be

$2.5 \pm 0.4 \times 10^8$ 1. mole^{-1} sec.$^{-1}$ at 1660°K and

$3.0 \pm 0.3 \times 10^8$ at 1815°.

These values agree with a long extrapolation of Baldwin's results at about 800°K, and combine with them to give:

$$k = 2.5 \times 10^9 e^{-7.7 \text{kcal./RT}} \text{ 1. mole}^{-1} \text{ sec.}^{-1}$$

Industrial Heating

Variety of Furnaces and Ovens Used in the Production of Light-Metal Casting. *Ind. Heating 28,* 1168 (1961) June (5 pp.)

Aluminum Industries, Inc., Cincinnati, Ohio, specialize in aluminum castings and handle many alloys of aluminum. This company produces a large volume of automotive pistons and many miscellaneous items. The gas-fired heating facilities represent a 24-hour heating capacity of over 32,000 lb of all types of aluminum castings.

"Walking Beam" Furnace Continuously Heat Treats Wide Range of Missile and Aircraft Steel Forgings. J. P. Molony. *Ind. Heating 28,* 1084 (1961) June (5 pp.)

A modern "walking beam" furnace is being used for normalizing, hardening, and solution treating forgings at Wyman-Gordon Co., Worcester, Mass. The 50-ft long furnace was built by Surface Combustion Corp., Toledo, Ohio, and is capable of treating 10,000 lb/hr of aircraft and missile forgings. Gas burners fire directly above and below the work in 4 temperature control zones.

Refrigeration

Solubility of Refrigerants 11, 21, and 22 in Organic Solvents Containing a Nitrogen Atom and in Mixtures of Liquids. *ASHRAE J. 3,* 71 (1961) July (6 pp.)

Several nitrogen-containing organic solvents were tested; some amines, nitriles, and formamides were found to be good solvents for Refrigerants 21 and 22, which contain a hydrogen atom and hence can hydrogen bond. The two best solvents found were dimethyl formamide and diethyl formamide. These two solvents produce mixtures that have C.O.P. (coefficients of performance) about 15 and 2% respectively, better than mixtures containing the dimethyl ether or tetraethylene glycol. C.O.P. values ranging from 0.27 to 0.44 were estimated for mixtures of formamides.

Solution Thermodynamics for Absorption Refrigeration. D. H. Andrews and R. A. Rousseau. A.G.A. Catalog No. 5/ACR June (1961) $1.50 (55 pp.)

Although there has been a great deal of study of the chemical and engineering aspects of gas-absorption refrigeration during the past thirty years, there is still no clear understanding of the precise relations between the chemical nature of the refrigerant fluids and the refrigeration efficiency of the system in which they are used. In view of the thousands of different choices that may be made for refrigerant and solvent, there is reason to believe that by no means all of the more efficient combinations have been investigated. The problem is how to find them. For this purpose, a better understanding is needed of the chain of relationships between chemical structure and ultimate refrigeration efficiency. Analysis indicates that little can be done to improve the thermodynamic efficiency of the absorption refrigeration system. However, there does appear to be the possibility of improving the engineering efficiency by finding a refrigerant and solvent that will yield rapid circulation of vapor coupled with low bulk of solution.

Space Heaters

Furnace Gas Manifold and Clamping Structure. J. R. Greiner and R. W. Eichorn (assigned to Lennox Industries, Inc.) U. S. 2,985,232 (1961) May 23.

In a gas furnace structure which includes multiple burner tubes and a long manifold pipe with a corresponding number of gas orifices, an improved mounting is claimed for the manifold. This mounting is comprised of a pair of brackets welded to each end of manifold pipe, and a pair of opposite facing cabinet brackets secured to the cabinet. These brackets are tapered toward the bottom, so that their side flanges cooperate when manifold assembly is lowered. In an intermediate space between the end brackets, a tapered wedge is inserted and driven tightly to hold the manifold in the desired alignment with the burner tubes.

Wall Heater and Rear Outlet Assembly Therefor. F. E. Fertig (assigned to the Coleman Company, Inc.) U. S. 2,982,283 (1961) May 2.

A wall heater is claimed in which the usual warm air collecting chamber is fed from below by side channels which cool the outer walls. In addition to the regular front outlet, a rear discharge outlet with control damper is provided to permit discharging warmed air into an adjoining room.

Submerged Combustion

Entrainment from a Submerged Combustion Evaporator. G. Rey. *A.I.Ch.E. J. 7,* 299 (1961) June (4 pp.)

Entrainment from a submerged combustion evaporator system was studied with sodium ion as a tracer. By measuring the ratio of the sodium concentration in the pot to that in the condensate, the entrainment removal performance of the evaporator system was studied under various conditions. It was observed that the log of the concentration ratio decreases with an increase in the temperature of the gaseous products of combustion as they emanate from the combustion chamber into the solution. This is attributed to the fact that a greater amount of the fine ($< 5\ \mu$) droplets of entrainment are formed in the evaporator as the temperature of the gases increases.

10. EQUIPMENT AND INSTRUMENTATION

Computers

Computer Control at American Oil. I. Application to the Process Unit. R. H. Crowther, J. E. Pitrak, and E. N. Ply. *Chem. Eng. Prog. 57,* 39 (1961) June (5 pp.)

A 140,000 bbl/day crude-distillation unit is tied in with an IBM 704 computer at Amoco's Whiting, Indiana refinery. From a long-range point of view, the experience gained throughout the development of computer control of crude oil distillation has shown how to approach such problems. The principles can be utilized to produce greater benefits for new units designed to make

full use of computer control—as a replacement for some conventional controls and a supplement to the rest.

Computer Control. II. Mathematics of Control. D. R. Kuehn and H. Davidson. *Chem. Eng. Prog. 57,* 44 (1961) June (4 pp.)

The computation of optimum operating conditions first requires preselection of the most critical dependent and constrained variables. The problem of maximizing (or minimizing) a function of certain variables while satisfying a set of equations in these variables rises in several contexts in process control. The first problem is adjustment of flow and enthalpy measurements to satisfy heat and material balances. The second problem, a crucial one, is the determination of changes in controllable operating variables that would cause the plant to run as economically as possible.

Computer Control. III. The Computer Systems. A. D. Pendleton, *Chem. Eng. Prog. 57,* 48 (1961) June (3 pp.)

The general purpose computer is the central component of the system. Final stage will be conducted with special purpose control computer for adjusting process unit instruments. The systems under study are capable of: 1) automatic data collection with information transferred on punched cards for use in "off-line" computation at a computing center; 2) fully automatic transfer of information to a computer to provide "online" computation; and 3) automatic adjustment control instruments at the process unit to provide "closed loop" computer control.

Computers and Chemical Engineers. W. M. Carlson. *Chem. Eng. Prog. 57,* 63 (1961) June (5 pp.)

Until two years ago, no generally useful system was available for planning research and development activities and then for keeping the plan up-to-date with revisions based upon new technical and cost data or revisions based upon the delays and breakthroughs encountered in work of this nature. So many different schemes had been tried and found wanting that most managements now accept the idea that scheduling of research and development is impossible, and they try to find suitable budgetary or other controls from which to measure progress.

Control by Special Purpose Analogs. G. W. Plant. *Chem. Eng. 68,* 205 (1961) June 12 (4 pp.)

Four things limit use of the special purpose controllers: 1) accuracy and reliability of components; 2) function capabilities of hardware—differentiation and integration must be time-based; 3) most technicians and engineers have had little experience with the type of process and control-system analysis necessary to apply analog elements effectively; and 4) there is a limitation in the receptivity of operations personnel and management. Use of special purpose analog controllers can provide solutions to previously difficult control problems at nominal cost, but the field should be thoroughly explored before any move is made toward more complicated control systems.

Failure of Automatic Control Systems. Part 1. J. R. Connel. *Can. Chem. Proc. 45,* 66 (1961) May (3 pp.); **Part 2.** *Ibid.,* 100 (1961) June (3 pp.)

Most process control system failures are due to one of six causes as shown: misapplication, equipment problems, inaccurate measurement, choice of factor, failure to balance the system, and recovery time. The failures which can be attributed to the control equipment itself are relatively few. The principal causes of control system failures are, in fact, the presence of disturbing factors, which have a greater influence on the controlled condition than has the automatic controller and excessively slow recoveries.

Controls

Process Control. Components. *Chem. Eng. 68,* 213 (1961) June (26 pp.)

A process control guide is given which provides useful data for components including evaluation of principles and the preliminary selection of process instruments. A similar guide appeared in the June 1957 issue, but in neither case is it intended as a substitute for manufacturer's literature or recommendations. Many sources have contributed to the preparation of the guide including users, manufacturers, and the literature. Members of the instrument industry who supplied information are listed.

Progress in Plant Measurements. W. H. Howe, P. H. Drinker, and A. M. Green. *Chem. Eng. 68,* 199 (1961) June 12 (6 pp.)

Since chemical processing is so dependent on proper measurement, highlights of the status of developments in the plant operations area are scanned. Happenings since publication of the 1957 process control are recalled, and an attempt is made to prognosticate events of the next four years. Progress in measurement can be summarized: areas showing the greatest improvement in the last four years have been analytical instruments and electronic transmission. Conditions measurements—the old standbys in processing—will be refined. But computers—both special-purpose and general-purpose—will emerge in the years ahead as instrumentation's most active development.

Heat Exchangers

New TEMA Standards Compared to Old. F. L. Rubin. *Petrol. Refiner 40,* 157 (1961) June (8 pp.)

Standards of the Tubular Exchange Manufacturers Association (commonly called TEMA Standards) were revised in 1959, made available in 1960, and have been slightly modified since. The most significant changes between the third edition and the fourth edition include: addition of size numbering and type designation; Deletion of TEMA Class "A" requirements for alloy construction; deletion of standard TEMA flange dimensions; deletion of TEMA "R" requirements for high hub flanges, for major exchanger flanges and for nozzle connections; addition of "seal welding," and "strength welding" requirements for tube to tubesheet joints.

Metering

Theory and Operations of Rotameters. L. M. Polentz. *Instruments and Control Systems 34,* 1048 (1961) June (3 pp.)

Knowledge of basic rotameter theory permits an engineer to select the proper rotameter—or even design a simple inexpensive 2-stage rotameter for high-low flow monitoring. Variable-area meters (rotameters) are becoming more popular because of their greater simplicity and ease of reading. Many articles in the literature discuss the use of rotameters for specific applications, few have discussed the fundamentals of variable-area meters to help practicing engineers better understand them.

Steam Generation

Detecting Service Failure in Power Plants. H. Thielsch. *Combustion 32,* 24 (1961) June (8 pp.)

The gradual silent collapse of the pressure members of the typical steam-power cycle has defied the otherwise reliable shift-by-shift, watch engineer's visual appraisal of equipment performance. Newer inspection techniques are now being perfected and a series of examples are shown isolating some of the major failures.

Temperature Measurement

Reactor Core Temperature Measurement. L. H. Shinault and T. F. McGrath. *ARS J. 31,* 799 (1961) June (5 pp.)

Paper describes the design and development of a thermocouple suitable for the measurement of temperature in a nuclear reactor core. The thermocouple junction is formed by applying thin films of tungsten and rhenium on a ceramic rod and coating these films with a ceramic insulating film. The thermocouple is capable of operating over a temperature range of 100 to 5000°F and has a response time of 50 to 100 milliseconds or less. Discussions of manufacturing methods and test results are presented.

Characteristics of Several Carbon Thermometer-Heaters at Low Temperature and in Magnetic Fields to 100 Kilogauss. E. W. Hornung and D. N. Lyon. *Rev. Sci. Instruments 32,* 684 (1961) June (4 pp.)

Several carbon thermometers have been prepared with various sizes of carbon particles and new rugged construction methods. The resistance of the thermometers has been measured as a function of temperature from 1.217 to 20.355°K and as a function of magnetic field from 0 to 94,500 gauss. No simple functional relationship holds between resistance and temperature or between resistance and magnetic field. An approximately square dependence of the resistance on the magnetic field holds for some thermometers at small fields, but in no case does this dependence continue at high fields.

Valves

Gas Valve Servicing. J. Lee. *Gas Heat and Comfort Cooling 12,* 37 (1961) July (4 pp.)

Servicing gas valves—both modern types and old ones still in field use—are described in this brief history which explains problems faced by the service man. Most models can be classified in six general categories. These include: diaphragm valves, sometimes known as "automatic snap valves"; magnetic valves or "solenoids"; self-generating system valves; motorized units which fall into 2 sub-divisions, one the type which utilizes a small motor geared to a valve lift, and the second which consists of a motor unit operating a hydraulic pump that transmits power to a piston operated valve seat; the electrically operated heat motor hydraulic valve; and the bi-metal type. In this first of a 2 part series, the diaphragm, magnetic, and self generating types will be discussed.

11. MATERIALS OF CONSTRUCTION, AND CORROSION

Cathodic Protection

Hugoton Wells Get Cathodic Protection. M. Blakely. *Oil Gas J. 59,* 98 (1961) June 19 (3 pp.)

Cathodic protection to curb external casing corrosion is being installed on a mass scale in the Hugoton and Panhandle fields of Kansas, Oklahoma, and Texas. About 200 Skelly Oil Co. wells are involved in an area nearly 200 miles long. The job was started because several casing leaks meant expensive workover jobs would be needed unless a stop was put to the casing corrosion in the area. Costs are estimated at about $350 per well.

Coatings

Zinc Dust Paints—Chemical or Electrochemical Protection? R. H. Chandler, *Corrosion Tech. 8,* 165 (1961) June (3 pp.)

There is a common area of agreement that zinc dust paints can protect steel exposed adjacent to surfaces covered by the paint and that cathodic protection, if present, is rapidly stifled by the formation and deposition of zinc corrosion products. In this review of early English and subsequent German research into the mechanism of the protective action, the weight of evidence favors the chemical protection theory.

Corrosion

The Corrosion of Aluminum. K. F. Lorking and J. E. O. Mayne. *J. Appl. Chem. 11,* 170 (1961) May (11 pp.)

The corrosion of aluminum at room temperature has been investigated in nine decinormal solutions over the *p*H range 2.0 to 12.0. Corrosion was dependent more on the nature of the anion than on the *p*H of the solution. The solubilities of hydrated and anhydrous aluminum oxide were examined and it was concluded that, except in the presence of chloride ions, corrosion was associated with the initial rate of solution of the anhydrous oxide. Potential and anodic polarization measurements indicated that the normal anodic reaction is the formation of anhydrous oxide, in the presence of chloride, bromide, and iodide ions soluble aluminum salts are formed.

Plastics

Reinforced Plastics for Corrosive Service.—Part I. R. M. Webster. *Chem. Eng. 68,* 154 (1961) June 26 (3 pp.)

A guide to the design of equipment for the chemical process industries is given. Applications and advantages of plastics are covered in this section; part 2 will discuss the selection of resin types. Selection of materials should be based on an adequate testing program. Calculated or estimated data are usually insufficient for designing a sound structure that will perform satisfactorily in a corrosive environment. Selective testing should be conducted by a person with a basic knowledge of resins, reinforcing materials and reinforced-plastic design.

12. ANALYTICAL METHODS AND TESTS

Catalysts

Determination of Acid Sites on Solid Catalysts by Ammonia Gas Adsorption. R. T. Barth and E. V. Ballou. *Anal. Chem. 33,* 1080 (1961) July (5 pp.)

A technique involving ammonia gas adsorption at elevated temperatures is used to determine surface acid sites on solid catalysts. Various catalyst materials are studied and adsorpton curves given. The automatic apparatus developed minimizes actual time for analyses.

Engineering Aspects of Solid Catalysts. O. A. Hougen. *Ind. Eng. Chem. 53,* 509 (1961) July (19 pp.)

A review and previously unpublished results are presented on those aspects of solid catalysts that are of special significance in the engineering problems of process design—such as pressure drops in the flow of fluids through pellet beds, optimum pellet size, pore structure and internal surface area of porous pellets, effective diffusivity in voids surrounding catalyst pellets, temperatures and concentrations at catalyst surfaces, effective thermal conductivity of packed bed, thermal conductivity of individual pellets, effectiveness factors of catalyst pellets, internal gradients of temperature and concentration, hold-up in flow reactors, and reaction rate constants based on bond energies. The five most serious sources of error in establishing a kinetics model from experimental data are discussed.

Chromatography

Compact Two-Stage Gas Chromatograph for Flash Pyrolysis Studies. S. B. Martin and R. W. Ramstad. *Anal. Chem. 33,* 982 (1961) July (4 pp.)

A two-stage gas chromatographic system is developed for the direct determination of reaction products of flash pyrolyses. The pyrolysis reaction is carried out in the gas stream and enters immediately into the first column. The system is portable and compact. Performance data are presented.

Gas Chromatographic Study of Unreduced Iron Catalysts. (Alpha-Fe_2O_3). G. M. Leuteritz, *Brennstoff-Chemie 42,* 154 (1961) May (3 pp. German text.)

Four iron (III)-oxides of differing K_2CO_3 content were tested by gas chromatographic methods. From the results the heat of adsorption of propane and butane were calculated, as well as surface area of the oxide. A comparison of the chromatographically determined surface with the corresponding BET values permits recognition that a portion of the micropores of the α-Fe_2O_3 are blocked by the K_2CO_3. This leads to a strong difference between the two methods with only 1% addition of K_2CO_3. Smaller additions ($< 0.8\%$) drive this blocking action into the background and instigate a surface increase which possibly is traceable to a hindering of the recrystallization mechanism of the α-Fe_2O_3 by the K_2CO_3.

Principles of High-Speed Gas Chromatography with Packed Columns. B. O. Ayers, R. J. Loyd, and D. D. DeFord. *Anal. Chem. 33,* 986 (1961) July (6 pp.)

Equations are derived which permit the calculation of minimum time to achieve a separation by gas chromatography. Certain general rules are outlined for the quantitative relationship among analysis time, column parameters, and operating conditions. For complex mixtures, it is best to set conditions for the resolution of the most difficulty separable pair of components in minimum time.

Quantitative Gas Chromatographic Analysis of Hydrocarbons with Capillary Column and Flame Ionization Detector. I. Halasz and W. Schneider. *Anal. Chem. 33,* 978 (1961) July (5 pp.)

A sensitive gas chromatographic procedure for determining hydrocarbons uses a capillary column and a flame ionization detector. Oxygen is used as the combustion and scavenging gas, which greatly increases the sensitivity of the method. The flame ionization detector is used because it is less complicated and its range of linear relation between concentration and signal is broader.

The Sampling System—Vital Link in the Process Chromatographic Control Setup. F. H. Harvey and W. J. Baker. *Oil Gas J. 59,* 147 (1961) June 12 (2 pp.)

The sampling system, installed between the chromatographic process analyzer and the process itself, is a very important part of the analysis and control setup, and contributes in large measure to the overall success or failure of the project. The function of the sampling system is to take a sidestream of process material and deliver to the analyzer a representative sample of the process stream at the pressure, temperature, flow, and phase conditions that can be accommodated by the process chromatograph.

Gas Analysis

Preparation and Analysis of Calibrated Low Concentrations of Sixteen Toxic Gases. Ammonia, Arsine, Bromine, Carbon-dioxide, Carbon-monoxide, Chlorine, Chlorine-dioxide, Ethylene-oxide, Hydrogen-chloride, Hydrogen-cyanide, Hydrogen-fluoride, Monoethanolamine, Nitric-oxide, Nitrogen-dioxide, Phosgene, and Stibine. B. E. Saltzman. *Anal. Chem. 33,* 1100 (1961) July (13 pp.)

A technique is presented for the preparation and analysis of calibrated low concentrations of toxic gases. These low-concentration gases are used in toxicological research, testing analytical methods, and evaluation of detecting instruments. Some 16 gas samples are accurately prepared. The technique may be used for other gases.

Quality Control of Gas. P. Zanen. *Rev. Gen. du Gaz (Belgium) 83,* 97 (1961) May-June (21 pp. French text.)

In February 1936, the Bulletin of Gas Engineers of Belgium published under this same title, an article by G. Vanden Berghe, Chief Engineer of the Distrigaz group. While it was specified as a preliminary note, the methods described were those agreed upon by both the producers and consumers. The Distrigaz group had been promoting their adoption if the gas corresponded to the chemical and physical properties stipulated in various contracts. Since them, however, the earlier standards have been adapted to new methods of gas production and the commission for the Bulletin has decided that their publication in their present actual form will be a means of holding the attention of numerous engineers interested in current methods of gas quality control.

Radioactivity Applications

Isotope Techniques for Nuclear Engineers. J. L. Putman. *Chem. & Ind., 733* (1961) June 3 (5 pp.)

The most versatile of all radioisotope techniques is that of radioactive tracers, by which radioactively labeled elements and compounds can be followed quantitatively through physical and chemical processes by measuring the radiation they emit. The value of the tracer technique in research for studying the kinetics of complex chemical reactions is well known, but its simple application to engineering problems of flow and translocation is almost equally important. Those in present use are bulk flow patterns, liquid flow measurements, liquid leak detection, gas flow and ventilation, gas leak detection, wear and transfer studies, autoradiography in metallurgy, analysis, fluorescence spectrometry, thickness and level gauges, density gauges, and flaw inspection.

Thiophenes

Infrared Spectra and Analytical Correlations of 24 Alkylthiophenes. D. M. Richardson, N. G. Foster, B. H. Eccleston, and C. C. Ward. *U. S. Bur. Mines. Rept. Investigations 5816,* (Washington, D. C.: U. S. Govt. Print. Off., 1961; 22 pp.)

The Bureau of Mines has participated in the American Petroleum Institute Research Project 48A (API-RP48A) program on the Separation and Identification of Sulfur Compounds in Crude Petroleum. The infrared spectra of 2-monoalkylthiophenes and 2,5-dialkylthiophenes for the 2 to 15μ range are reported. Correlations for determining the 2-alkyl and 2,5-dialkyl substituted thiophenes are derived from this information. The 2 alkylthiophenes shows a unique pattern in the 5.5μ to 6.5μ region, while the 2,5-dialkylthiophenes show a distinctive pattern in the 5.6μ to 6.7μ region. A skeletal vibration occurs in the 9.5 to 10.0μ region for all of the thiophenes investigated.

Water

Water Determination by Reaction with 2,2-Dimethoxypropane. F. E. Critchfield and E. T. Bishop. *Anal. Chem. 33,* 1034 (1961) July (2 pp.)

A rapid spectrophotometric method for determining water is based on the acid catalyzed reaction with 2,2-dimethoxypropane. The acetone formed is measured by infrared absorption at 5.87 microns. The method is applicable to determination of water in organic solvents.

13. BASIC SCIENCE

Adsorption

Multimolecular Adsorption Equation. R. R. Rounsley. *A.I.Ch.E. J. 7,* 308 (1961) June (4 pp.)

An equation is derived for the multimolecular adsorption isotherm in the range where capillary adsorption is insignificant. The equation is demonstrated to apply quantitatively to the entire range of relative vapor pressures. It is shown that this equation reduces to the equation of Brunauer, Emmett, and Teller at lower relative vapor pressures. Application of this equation to data in the literature showed good agreement. The standard deviation of the data from the equation was in the same order of magnitude as the scatter data themselves. Although the application of this equation was largely to water vapor adsorption systems, several applications to other systems correlated equally well.

Compressibility

The Compressibility of Carbon Dioxide and Nitrous Oxide at Low Pressures. L. Turlington and J. J. McKetta. *A.I.Ch.E. J. 7,* 336 (1961) June (2 pp.)

A modified Edwards density balance was used to measure compressibility of carbon dioxide and nitrous oxide at pressures under 2.0 atm and over a temperature range of —30° to 75°C. Second virial coefficients were calculated for the temperatures covered in this investigation and compared with data presented in the literature for both gases. The compressibility data are estimated to be accurate within ± 10% of the actual compressibility factor.

Compressibility of Real Binary Gas Mixtures. J. S. Busch and L. N. Canjar. *A.I.Ch.E. J. 7,* 343 (1961) June (3 pp.)

The P-V-T-x properties of binary gas mixtures, and their dependence on reduced temperature and pressure, have been reviewed in detail. A modified form of Kay's original method for estimating P-V-T-x properties of mixtures is suggested for purposes of engineering calculations.

Volumetric Properties of Gas Mixtures at Low Temperatures and High Pressures by the Burnett Method: The

Hydrogen-Methane System. W. H. Mueller, T. W. Leland, Jr., and R. Kobayashi. *A.I.Ch.E. J. 7,* 267 (1961) June (6 pp.)

A Burnett-type of apparatus for the study of volumetric behavior of gases at low temperatures and high pressures was constructed. The apparatus was used to study the volumetric behavior of methane and four mixtures of hydrogen and methane from +50 to —200°F and pressures as high as 7,000 psi. Experimental data were used to obtain the second virial coefficients for pure methane and for the mixtures. Results of approximately 600 experimental points were used to obtain a table of compressibility factors for methane and the mixtures at even increments of pressure and temperature.

Fluid Flow

Analysis of Fluid-System Dynamics. A. R. Peck. *Chem. Eng. 68,* 193 (1961) June 12 (6 pp.)

Normally, in fluid flow systems only the steady state is considered, in which there is only frictional resistance, and for which Ohm's law is $P = RQ$. However for control purposes, the system is not at steady state, and inertia (inductance) and material storage (capacitance) in the system must be taken into account. Impedance must be recognized with a phase angle, $P = ZQ$ or $P/Q = Z$.

Two-Phase Concurrent Flow in Packed Beds. R. P. Larkins and R. R. White with D. W. Jeffrey. *A.I.Ch.E. J. 7,* 231 (1961) June (9 pp.)

Pressure drop and liquid saturation accompanying two-phase concurrent flow have been studied in a variety of packings and with gas-liquid systems having a wide range of fluid properties. Two basic flow patterns were observed with nonfoaming systems. Correlations of pressure drop and liquid-saturation data were obtained in terms of the single-phase friction losses for the liquid and the gas when each flows alone in the bed. Deviations from the correlation with foaming systems are discussed and illustrated with sample data.

Uniformity and Stability of Fluidized Beds. H. C. Bailie, L. T. Fan, and J. J. Stewart. *Ind. Eng. Chem. 53,* 567 (1961) July (3 pp.)

To obtain a quantitative measure of the effect of physical variables of particle size distribution, gas flow, velocity, and bed height on the heterogeneity of a fluidized bed, an instability index is defined. Bed densities were measured using γ-ray density gage and the index defined as the ratio of the variance of the density of the fluidized bed to that of a packed bed of the same average density. Owing to the random nature of the radioactive source and the instability of the fluidized bed, the data were treated statistically. The instability of the bed increased with increasing gas velocity and bed height. The expanded bed height was easily obtained from the point of maximum instability.

Heat Transfer

Simultaneous Transfer of Heat and Mass. Part I. J. Coates and B. S. Pressburg. *Chem. Eng. 68,* 95 (1961) May 29 (6 pp.) **Part II.** *Ibid.,* 131 (1961) June 26 (3 pp.)

Humidification, water cooling, drying, and a number of other operations involve the simultaneous transfer of heat and matter between phases. Interest may be in one transfer or the other, such as in the energy changes in water cooling, or in the mass transfer in dehumidification. Each transfer influences the other and must be taken into account in designing or analyzing the equipment in which the operation takes place. Special methods are necessary to analyze the processes. While the principles and differential balance for dehumidification can be applied their mathematical solution is more difficult because the water temperature cannot remain constant. Formal integration is substantially impossible even though the units are operated in a countercurrent fashion.

Heat Wave, Radiating Energy from Front. E. M. Andriankin. *Soviet Phys.-Tech. Phys. 4,* 1258 (1960) May (5 pp.) (Translation of *Zh. Tekh. Fiz., Akad. Nauk SSSR 29,* 1368 (1959) Nov. (5 pp.) by American Inst. Phys., Inc. [From *Appl. Mech. Rev. 14,* 482 (1961) June.]

In this article, the propagation of a nonprogressive heat wave, radiating energy from the front, is investigated. The case for which the path of the radiation in the cold gas is large, for all frequencies below the critical frequency ω, and is small for high frequencies is examined. The path of the quanta in the heated region is assumed to be much smaller than the radius of the wave front, since the radiant energy transfer takes place by means of heat conduction.

From author's summary

Turbulent Convective Heat and Mass Transfer from Accelerating Particles. I. S. Pasternak and W. H. Gauvin. *A.I.Ch.E. J. 7,* 254 (1961) June (7 pp.)

The rate of evaporation of acetone from single particles accelerating freely in a downward concurrent turbulent air stream was studied over a range of air velocities from 40 to 70 ft/sec, and at a constant air temperature of 410°F. The particles consisted of celite in the shape of spheres, cubes, disks, and cylinders, varying in size from 0.15 to 0.40 in. Accurate particle velocity data were obtained with a new radioactive tracer technique, and high-speed photography. Two positions along the column permitted measurement of the rate of rotation and showed that the particles rotated in a random manner.

P-V-T Behavior

The P-V-T Behavior of Diatomic Substances in Their Gaseous and Liquid States. R. Byrne and G. Thodos. *A.I.Ch.E. J. 7,* 185 (1961) June (5 pp.)

The critical compressibility factor has been used as a criterion of the P-V-T behavior in the gaseous and liquid states for the diatomic gases, nitrogen, oxygen, carbon monoxide, nitric oxide, chlorine, and hydrogen chloride. Reduced densities for these substances have been calculated from available literature data. These

correlations exhibit similar behavior as expected from their similar critical compressibility factor as a correlating parameter has been verified by the favorable comparison of the P-V-T behavior of substances other than diatomic gases including argon, krypton, xenon, and methane.

Temperature Measurement

Recombination of Atoms at the Surface of Thermocouple Probes. K. Tsu and M. Boudart. *Can. J. Chem. 39,* 1239 (1961) June (8 pp.)

When atoms produced by a discharge at one end of a closed cylindrical tube diffuse down the tube, their rate of recombination on the walls of the tube can be determined by measuring the temperature of a probe traveling along the axis of the tube. However, the catalytic activity of the probe under specified conditions, may appear to be the same whatever the catalytic activity of the probe material. This effect is offered as an explanation of earlier findings which were recently reported, where essentially the same recombination probability for hydrogen atoms on 12 different metals occurred.

Thermal Conductivity

A Simple Method of Determining the Thermal Conductivity of Solids. J. Schroder. *Philips Tech. Rev. 21,* 357 (1959/60) No. 12. (5 pp.) [From *App. Mech. Rev. 14,* 483 (1961) June.]

Author describes a unique experimental method and associated apparatus for determining thermal conductivities of solids. The two opposite faces of a cylindrical sample are maintained at constant temperature by boiling of two different liquids having boiling temperatures which differ about 20°F. Heat-transfer rate is obtained by measuring time to collect a given volume of condensate. Method is especially attractive if device is calibrated, since ΔT is not affected by samples of different conductivity; only the time to collect a specific volume is changed. Calibration curve of thermal resistance against time to collect condensate is a straight line.

A. J. Shine, USA

The Thermal Conductivity of Hydrocarbon Gases at Normal Pressures. D. Misic and G. Thodos. *A.I.Ch.E. J. 7,* 264 (1961) June (4 pp.)

Dimensional analysis has been applied for the correlation of the thermal conductivity of a gas to its temperature, molecular weight, heat capacity, and critical constants. This approach indicates that the group $k^* \lambda/C_p$ should be a function of z_c and T_R, where $\lambda = M^{1/2} T_c^{1/6}/P_c^{2/3}$. Experimental thermal conductivities of hydrocarbons at normal pressures (approximately 0.2 to 5 atm) have been used to develop two relationships. The first is applicable to all types of hydrocarbons for $0.6 < T_R < 3.0$ with the exception of methane and the cyclic hydrocarbons below $T_R = 1.0$, for which the other relationship is applicable. These two relationships have been used to calculate thermal conductivities for 28 gaseous hydrocarbons for which the experimental data are available. Calculated values for normal paraffins, isoparaffins, olefins, diolefins, acetylenes, naphthenes, and aromatics produce an average deviation of 2.4% from experimental values for 154 points considered.

Thermodynamics

Exergy Diagrams for Water and Water Vapor. Z. Rant. *Brennstoff-Warme-Kraft 12,* 297 (1960) July (5 pp. German text.) [From *Appl. Mech. Rev. 14,* 478 (1961) June.]

Diagrams for obtaining the exergy (technical work capability) of water and water vapors are presented and 2 practical examples are calculated with these diagrams. Together with the description of the exergy diagrams for air and combustion gases previously published in this journal, this constitutes the means for carrying out exergetic investigations in steam technique.

From author's summary

Thermo Data for Petrochemicals. H. A. G. Chermin. *Petrol. Refiner 40,* 179 (1961) June (4 pp.)

The important thermoproperties are presented for all gaseous n-l-alkanethiols from methanethial through n-decanethiol. Measurements and calculations made on the thermodynamics of organic sulfur compounds during the last decade have yielded sufficient data to make it worthwhile summarizing these data and extending them to the higher homologs. With the help of the data thus found, contributions to the free enthalpy of formation (Gibbs' free energy of formation) for sulfur groups can be calculated. Data are presented on normal alkanethiols and on the contribution of a primary-SH group to the free enthalpy of formation. Data on other organic sulfur compounds will be given in later work.

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Engineering for Industry, Journal of (Series B)
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